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GEOLOGY IN NATIONAL AND EVERYDAY LIFE[1]

By Dr. GEORGE R. MANSFIELD

U. S. GEOLOGICAL SURVEY

INTRODUCTION

To a surprisingly large number of people the word geology suggests nothing definite or practical, nothing associated with national or everyday life. Nevertheless, geology is concerned with the materials man uses in building his houses and great industrial plants. It deals with the metals of which his car is composed and with the fuels with which he drives his car or heats his house. It has to do with the seasoning and preservation of his food, with the water he drinks and with the scenery which greets his eyes every morning. It considers the destructive hazards that form part of his environment in many parts of the world, such as floods, earthquakes and volcanic activity, and is concerned as well with the gentler moods of nature that calm his spirit and inspire his imagination.

Minerals enter into all phases of our modern civilization. Geology deals with the occurrence and distribution of minerals and with the laws and forces that tend to create or destroy them. Industry must know where suitable supplies of minerals for its needs may be obtained and what conditions are imposed by nature on their successful recovery and exploitation. Federal, state and local governments must know whether

[1] Address of the retiring vice-president and chairman of the Section on Geology, American Association for the Advancement of Science, Indianapolis, December 31, 1937. Published by permission of the Director, Geological Survey.

mineral supplies, within their respective jurisdictions, are of suitable quality or adequate to meet the needs of their citizens. They must have information on the geologic conditions affecting the sites of constructional works, such as dams, reservoirs, bridges and the foundations of public buildings; on the problems of water supply and sanitation; and on the wise use and conservation of their mineral resources. The individual must earn his living and gain his inspiration amid surroundings from which geology constantly speaks to him. It seems pertinent, therefore, to consider in some detail the relation between geology and our national and everyday life.

RAMIFICATIONS OF GEOLOGY

Geology is concerned with all agencies and phenomena that have affected the earth in the past or are affecting it now. Some agencies, such as the sun's energy, act upon the earth entirely from without. Others act chiefly at the earth's surface. Among them are streams, glaciers, winds and waves. Still others, such as volcanism, earthquakes and mountain-building agencies, act chiefly within the body of the earth, though each of these may have strongly developed surface manifestations. Gravity acts from without the earth as an astronomical agency, but is also associated with every activity at the earth's surface and within its mass.

The geologist reads and interprets the geologic record in the rocks. But this involves consideration of the agencies above mentioned and through them the use of facts and techniques of other sciences, principally chemistry, physics, biology and astronomy. A border zone lies between geology and each of these sciences so that whether an investigation is geological may depend on its view-point or emphasis rather than on the facts or techniques employed.

The borderline sciences, geochemistry and geophysics, have developed to consider problems that fall between the adjacent fields indicated by the names.

Mineralogy may be cited as an example of the dependence of geology on other sciences. Mineralogy has long been dependent on chemistry and optical physics for accurate determinations of mineral species. More recently it has made use of the x-ray. Mineralogy applied to rock study has developed into petrology; similarly applied to the study of useful minerals it has developed into economic geology. Both geochemistry and geophysics are extensively utilized in economic geology, and geophysics has now become an important aid to the petroleum geologist in his search for oil and gas. However, the view-point of geology, the interpretation of the earth's history, is its own, and geology's dependence on other sciences is probably no greater than their dependence on it.

Geology ramifies also into business, national and private life.

GEOLOGY AND THE MINERAL INDUSTRIES

The mineral industries include, generally, those dependent on the discovery and mining of mineral substances and their manufacture into useful products. They give employment to many thousands of our citizens. According to the Minerals Yearbook 1937, published by the Bureau of Mines, the mining industry by itself ranks last among the four primary industries in the United States with respect to capital invested, value of products or number of workers employed. Actually, however, these industries are interdependent. Manufacturing needs minerals both for its machines and for the power to operate them. The products of mines contribute nearly two thirds of the revenue freight handled by the railroads and about one fourth of the ocean-borne traffic. Agriculture requires minerals for fertilizers and farm implements, and minerals serve to link farms and markets. Highways, railroads, trucks and trains are all of mineral origin.

To those who actually mine coal, iron ore and other minerals, the relation of geology to their everyday lives can hardly fail to be evident. The continuity of a vein, the nature of the ground, whether hard or soft, broken or stable, are factors which control the nature and speed of each day's work and the daily risk of personal safety. Similarly, the oil or water driller must keep close watch of the nature and attitude of the rocks through which he is drilling his well. Those who fabricate the product of the mines and wells are farther removed from the direct effects of geology, but they are no less dependent on it, because their employment is contingent on the constant supply of a uniform material suitable for the manufacture of their special product.

Water is as truly mineral as petroleum or other hydrocarbons, and the question of adequate water supply is closely linked with mineral industries. Water is so essential to all phases of human life that no one can escape the consequences of failure, interruption or contamination of his regular supply. An adequate supply of water is contingent on numerous factors, many of which are geological.

The economic geologist is employed to aid in the discovery of mineral resources, to work out their relations in the ground and to obtain quantitative data on which to base estimates of reserves. He must consider grade and accessibility, as these factors ultimately determine whether a given mineral deposit can be exploited at current price ranges. The use of sound geological investigation and advice is essential if waste and suffering are to be avoided by the public when attempts are made to work an unprofitable mining

property, to drill for oil in unfavorable places or to unload questionable mining or drilling enterprises on the market.

Metals. The geologist engaged in studying metallic minerals must devote a large share of his time in the field to the available underground workings in such mines as are accessible to him, besides acquainting himself with the surface geology of as much of the region as the limits of his time and funds will permit. He thus gains a better three-dimensional picture of the whole geologic set-up than would be possible from a study of surface relations alone. His maps, sections and laboratory studies serve to control actual mining operations and guide explorations for further supplies of ore. The increasing use of geologists on the staffs of mining companies bears witness to the increasing need of the mining industry for geologic advice and to the growing recognition of that need.

Non-metals. In the field of non-metallic mineral deposits the recognition of the need of geologic advice has grown more slowly and in fact can hardly yet be said to be wide-spread. Non-metallic mineral resources are in general so abundant, lie so near the surface and are so cheap, relatively speaking, that producers have given little thought to their geologic aspects. However, it not infrequently happens that a producer, say, of sand and gravel, locates his plant near a talus pile, which he mistakes for a bedded deposit of suitable thickness and quality. When further work discloses that the actual deposit from which the talus is derived is merely a thin cap at a higher elevation, he is faced with the problem of relocating his plant, changing its layout or abandoning it altogether.

Some industries in the non-metallic field utilize underground methods of mining. For example, mica, feldspar, talc, magnesite, gypsum, fluorite and some phosphates are among the minerals so mined. More recently underground methods have been successfully applied to the mining of limestone, slate, sandstone and even granite at different places. Special processes for recovering salt and sulfur by underground solution or melting and pumping have been devised which differ from ordinary mining methods, but the successful location and development of such an enterprise, as in the other instances, depends fundamentally on knowledge of the geology of the area in which lies the deposit to be mined, or otherwise recovered.

Again supplies of construction materials for building and other activities in the vicinity of large cities or large engineering projects tend to become depleted fairly rapidly and search for such materials has to be extended farther and farther from these centers. Here a good geologic map is of the greatest service whether or not it was originally prepared to serve economic needs. For regional planning, where constructional activities are contemplated, the areal geologic map of the United States has been found a valuable guide for more detailed investigations. Similarly state geologic maps and geologic maps of individual areas, such as those provided in the folios of the Geological Survey, have repeatedly proved their worth in locating supplies of necessary construction materials. For example, the state geologic map of Alabama shows the distribution in the northern part of the state of extensive deposits of gravel in areas mapped as Tuscaloosa formation and large areas of valuable limestone for building in the Bangor limestone. Special economic maps, such as that of the Tennessee Valley, prepared by the Geological Survey, indicate the distribution of a wide variety of mineral deposits. The use of such information may often result in large savings both in time and money, not only by pointing out more favorable areas but also by preventing search in unfavorable areas.

Fuels-coal. Geologists in federal and state surveys, as well as those in private employ, have labored many years to make known the nature and extent of the nation's coal resources. We now know in greater or less detail where the deposits of coal of different ranks, from lignite to anthracite, lie, how extensive they are, how rich in heating value, and which beds among them are best adapted for such purposes as coking and steam production. Some years ago the Geological Survey published a map showing the nature and distribution of the coal fields of the United States, which has proved a very useful summary. Although the number of publications emanating from these sources is large, the work is far from complete because of the wide distribution of the deposits and the refinements of study needed in getting desired information.

Petroleum and Natural Gas. In recent years the search for new supplies of petroleum and natural gas has become increasingly the task of the geologist and the geophysicist. In this task paleontology has acquired greater economic interest and importance than in any other branch of the mineral industry. Fifty years or so ago who would have thought that a matter of prime importance to a great industry would be the stratigraphic position and depth below the surface of certain beds of rock whose chief characteristic is their content of tiny fossils? Yet now in certain oil-bearing regions such beds serve to outline, or help outline, the shape, size and position of oil and gas pools. Our knowledge of subsurface geology, on which the search for oil now largely depends, has been built up by the geologist, patiently gathering and comparing data from well cuttings and cores, identifying fossils—including many of microscopic size—determining mineral particles and preparing the maps and sections on which the collected data are assembled and summarized.

The geophysical prospecting now in wide use in the search for oil and gas derives much of its usefulness from the great body of data assembled and integrated by geologists. The effectiveness of geophysical combined with geologic methods has been well shown in many parts of the United States, especially in Texas and Louisiana near the Gulf of Mexico, where many oil fields and salt domes have been thus located, and more recently in the central Illinois basin. The geologist is indispensable to the oil industry. The literature on geophysical prospecting is increasing at a rapid rate. A quarterly Geological Survey bulletin of about 300 abstracts is now required merely to outline these publications.

The contributions of the petroleum geologist to geologic literature and philosophy have greatly stimulated interest in the deeper rocks and structures of the earth's crust, in problems of sedimentation, ancient shorelines and continental history. In this connection, David White's carbon ratio theory deserves particular mention. The essence of it is that organic substances in sedimentary rocks share in the ordinary metamorphic changes induced by compaction and folding of the deposits. Oils and coals of different ranks are produced and modified by these changes at relatively low temperatures and by a sort of cracking process, whereby the more volatile hydrocarbons are liberated while the fixed carbon remains, thus increasing the ratio of the "fixed" to the volatile carbon. As these metamorphic effects become more intense, the cracking process reaches a "dead line" beyond which no oil or gas pools may be expected. This theory explains many facts regarding the mode of occurrence of petroleum and some of the differences in its character from place to place. By indicating areas where the search for oil would be unprofitable, it has saved producers millions of dollars.

The relationship of geology to the life and interests of a community is nowhere more definitely recognized and more strongly appreciated than among the people living in the oil-producing parts of the country. Even a brief sojourn in such a community suffices to show that the common man has a keen understanding of such geologic terms as anticline, structure, dip and strike, and of the part these features may play in finding oil.

Geology in the Constructional Industries

In recent years the imagination of the public has been stirred by plans involving engineering construction projects on an unprecedented scale. Some of these projects are already in progress and popular attention has been directed to such centers as Norris, Tennessee; Guntersville, Alabama; Boulder Dam, Arizona-Nevada; Bonneville Dam, Oregon-Washington; Grand Coulee Dam, Washington, and Fort Peck, Montana, where construction of large river-control projects is already well advanced.

The geologic conditions at each of these sites presented problems or even hazards that had to be solved and met by special engineering devices before success for the constructional end of the project could be assured. At one site, for example, the difficulties centered in the relative porosity and cavernous character of the limestones on which the dam was to be seated. At another, ground movement, through landslides, introduced serious hazards. At still another the occurrence of large supplies of hot water denoting disturbed structural conditions at the proposed dam site had to be taken into account. The engineers in charge, mindful of previous disasters where work of this sort had been done without sufficient regard to attending geological conditions, called upon geologists for help. As the sites selected have special advantages not easily duplicated, it remained for the geologist and the engineer jointly to work out methods for overcoming these difficulties. This seems in large measure to have been accomplished, and the public has much reason to hope that the structures will prove stable when completed.

Some years ago the government undertook the project of building a large reservoir in a western valley for the purpose of irrigation storage. The site had been selected after a careful investigation by a well-known consulting engineer, who reported that it had several advantages over competing sites and that the construction involved no special problems. When drilling began for the selection of a dam site, trouble arose from drilling water, which disappeared almost as fast as it could be poured into the drill holes. Geological investigation showed that the ground-water table in the vicinity of the proposed dam site was nearly 100 feet below the surface. The rocks on which the dam was to be seated were porous and fractured lavas, resting on thick but poorly consolidated and porous volcanic ash. The proposed dam would surely allow water to flow away beneath and around the dam without providing the desired storage. The site was abandoned, and the resulting saving to the government in avoiding the unwise proposed construction was approximately $2,000,000.

Although the geologist is indispensable in helping to solve problems encountered in great constructional projects, he is even more necessary when it comes to the consideration of the sources of supply and the nature of the mineral substances that enter into any modern constructional project, great or small. At the time the Boulder Dam was under construction, the technical journals and locally the daily newspapers carried accounts of the enormous quantities of sand and gravel, cement, steel, etc., that were needed and used, and of special types of equipment designed to

handle these materials. Similarly, for the other projects, much information of this sort is available.

Some years ago E. F. Burchard and G. F. Loughlin compiled construction data, not published, for the Interior Department, North Building, in Washington, D. C. This is a modern office building, completed for occupation in 1917. It occupies an entire city square. According to Burchard and Loughlin's figures, about 8,000 tons of metals, more than two thirds of it structural steel, was utilized. Interesting items in this connection are 20 tons of bronze in locks and 49 miles of wire used in signalling and lighting but not for telephones. The non-metallic minerals used total about 82,500 tons. Of this amount more than a third consisted of sand, gravel and crushed stone; clay products, largely hollow tile and building brick, made up another third. Then came Indiana limestone, plaster and cement and a number of others. These materials came from 28 states and 3 foreign countries.

Oliver Bowles in the magazine, *Stone,* June, 1932, gives an account of the stones used in the Department of Commerce Building in Washington. This building covers a ground area of approximately 8 acres and is one of the largest office buildings in the world. Indiana limestone was the stone most largely used. Of this about 700,000 cubic feet, or 1,100 carloads, was required. Granite from Stony Creek, Connecticut, amounted to 75,000 cubic feet. Other interesting items about this building include 7½ miles of corridor floored with terrazzo chips patterned with small tile; 6 miles of wall base along the corridors covered with polished black Isle La Motte, Vermont, marble, and more than 16 miles of baseboard manufactured from slate obtained in the Pen Argyl district of Pennsylvania. The stones used in this building came from ten states and one foreign country.

The figures cited show something of the nature, diversity and amount of the mineral substances that enter into the construction of large modern buildings. When one considers how many new buildings, both large and small, are being constructed throughout the country each year, and realizes that to obtain an idea of the total quantity of minerals used in their construction, the figures given above must be multiplied enormously, he can better understand the meaning of the statistical summaries of mineral production published each year, formerly by the Geological Survey and now by the Bureau of Mines. These figures, of course, include not only the costs of minerals entering into building construction, usually f.o.b. mine or quarry, but the entire range of industrial and commercial activity in which minerals are used. For 1936, the latest year for which figures have been assembled, the Bureau of Mines shows a grand total of $4,582,000,000 for the value of the output of mineral products in the United States. The greatest contributor was mineral fuels ($2,706,300,000) followed by metallic products ($1,064,000,000), non-metallic products ($789,700,000) and "unspecified" ($22,000,000).

It has been emphasized by geologists and economists, but will bear repetition, that the mineral resources of the country are diminishing assets. When once used they can only in relatively small measure be reclaimed and used again. Periodic mineral inventories, therefore, are essential to provide the best picture of our outlook regarding the future supplies and utilization of minerals, and these inventories are founded on geologic information.

Geology in Public Relations

Governments—federal, state or local—have many problems that involve some relationship with minerals, in the solution of which the geologist may and often does play some important part. The Federal Government and some of the states, for example, Texas, own large tracts of public land, the administration or disposal of which involves a knowledge of the mineral resources that they contain. Many cities and towns own land from which stone may be quarried or sand or gravel be removed.

Geological Survey. The Federal Government, the largest land-holder, early recognized the need of information regarding its public lands. Thus arose the succession of surveys, which finally led to the establishment in 1879 of the Geological Survey, whose director was charged with "the direction of the Geological Survey and the classification of the public lands and examination of the geological structure, mineral resources, and products of the national domain." Though many of its activities relate specifically to the public lands, the scope of the organization is broader, and it may do work for public purposes in any of the states, territories or insular possessions.

Its work has greatly expanded since the early days. The names of its six branches indicate the general scope of its present activities:

- Geologic branch (includes wide variety of geologic studies and related chemical and physical work).
- Topographic branch (topographic mapping, base maps, etc.).
- Water resources branch (surface and ground water divisions).
- Conservation branch (land classification, mineral leasing, power sites, etc.).
- Alaska branch (geology, topography and mineral resources).
- Administrative branch (includes library).

Besides geologists these branches employ many engineers, chemists and physicists, a clerical staff and laborers. The continuous service of one or more legal

advisers is also required. Nevertheless, the central purpose about which the entire organization revolves is the extension of geologic knowledge and the application of this knowledge to public problems involving the mineral wealth of the country, especially the public lands, and laws and regulations relating thereto.

Other Governmental Agencies. Other government agencies besides the Geological Survey have need for geologists and geologic advice. Some of them call upon the Survey to do specific pieces of work or carry out special investigations. Thus the Survey has examined many tracts of land for the Forest Service in pursuance of legal obligations placed upon that organization to obtain such examinations prior to the purchase of additional lands for forest reserves. The Indian Service has requested mineral examinations of certain Indian lands prior to opening for settlement or disposal and that organization and the Bureau of Reclamation have asked for damsite investigations. This last organization and some other bureaus originated in the Geological Survey. The Navy Department has asked for geologic aid in selection of sites for special structures and of tracts of land for petroleum reserves. The National Park Service has asked for geologic information for administrative purposes and to further the educational and recreational use of the parks. The Tennessee Valley Authority has asked assistance in the valuation of mineral-bearing lands about to be flooded. The Reconstruction Finance Corporation and the Securities and Exchange Commission have called upon the Survey for advice in their respective fields as to applications for loans of public funds and as to issuing permits to sell securities based on underlying mineral properties.

On the other hand, a number of federal organizations, recognizing the need of geologic information and advice, have attached geologists to their staffs or have built up separate geologic staffs in order to obtain more direct control of such work for their special purposes. Among these are the Army Engineer Corps, the Reclamation Service, National Park Service, the Soil Conservation Service and the Tennessee Valley Authority. The increasing tendency of such organizations to seek geologic advice indicates a growing appreciation of the varied services geology may render.

State Geological Surveys. Before the Federal Government took cognizance of geology as an aid to the better understanding and solution of its problems affecting mineral lands, and resources, some of the states had established geological surveys and published reports. The two Carolinas, North Carolina in 1823, and South Carolina in 1824, were the first to take steps in this direction, followed by Massachusetts in 1830. From that time on more and more states have taken up geologic investigations. Most of the early surveys were discontinued, but many were revived, some of them several times. The New York Survey, however, has been broadly continuous in its activity and name since its inception in 1836. Now the only states that appear to make no specific provision for geologic work within their boundaries are Delaware and Massachusetts. The state surveys, though held within state lines and thus restricted in their fields of operation, have given an excellent account of themselves and have rendered most valuable service to their people and to the country as a whole, as well as to geological science.

Services Rendered by Official Surveys. Besides the applications of geology in the fields of engineering, construction and search for supplies of different minerals, which to a greater or less extent are regular duties of official surveys, its application in land classification, water supply problems, sanitation, legal questions and miscellaneous information service deserve attention.

Land Classification was one of the duties imposed on the Geological Survey by its organic act, but little systematic geologic work was done in this connection until the rise of the conservation movement in the first decade of this century. Attention then was focused on such mineral resources as coal, oil, natural gas, phosphate and salines on public lands, and the interest of the nation as a whole in their proper conservation and use was aroused. Congress passed legislation reserving mineral rights to the government, setting up reserves for special purposes, and providing for the lease and exploitation of public mineral lands. A necessary corollary was the acquirement of more precise information regarding such lands. The Geological Survey thus began and has since continued systematic surveys to show accurately the distribution of such minerals with respect to the established subdivisions of the public land and to measure and sample the deposits for purposes of computing reserves. The acreage withdrawn from or restored to entry and the estimates of reserves have been modified from time to time as new information has become available. They have formed the basis of national planning and legislation. Besides this, land classification data are extensively used by the General Land Office in administering public lands.

Water Supplies. In the better watered parts of the United States and other countries, questions of water supply have not, on the whole, seemed serious until recent years. The situation is different in more arid regions where water is the crux of the question, whether a given area can be used agriculturally or industrially, or perhaps at all. With the rapid expansion of cities in the more thickly settled areas and the increased demands for water in some western states,

questions of water supply have assumed national importance. Investigations and measurements must be made both of the available surface water and of water in the ground. These are long-continuing projects because rainfall, which controls both the surface and the ground supply, fluctuates so that investigations, covering only short periods, are likely to be deceptive and undependable.

The problems of proper development and utilization of water involve the cooperation of the engineer, the geologist and the chemist. The engineer is concerned with its production or accumulation, its transportation and handling as a commodity; the geologist with the character (thickness, porosity, etc.) and position of the water-bearing beds, their recharge from available rainfall and their possible contamination by salt water or other undesirable substances. With the engineer he is concerned with the character and stability of rocks affected by tunnels, aqueducts, dams and other structures. The chemist determines the quality of water as regards mineral and organic content. Mineral water, through clogging or staining, may be injurious for industrial use. Mineral substances in solution may also affect health. For example, fluorine detected in the waters of some of the southwestern states has proved injurious to the enamel of human teeth. Organic matter is deleterious to health.

Sanitation. Closely related to the question of water supply is that of sanitation and the disposal of sewage and other wastes. If proper regard is not paid to geological conditions, water supplies otherwise suitable may become contaminated. In some limestone regions where underground channels have been enlarged by solution, water may pass quickly from sources of contamination to places of use without being filtered or purified as they might be by passing through sequences of rocks of normal porosity. Thus the geologist's advice may be valuable to the sanitary engineer.

Legal Questions. Matters in litigation not infrequently hinge on geologic data. The mining industry has been afflicted by litigation in connection with the so-called "apex" law. Many distinguished geologists have participated in these affairs. Frequently the available data have been so incomplete as to allow many differences of opinion among the experts. Boundary disputes between states or individuals, where the position of a stream is involved, have frequently hinged on geologic evidence, as in the case of the Texas-Oklahoma boundary along the Red River some years ago.

Informational and Miscellaneous Services. All the state geological surveys, as well as the Federal Geological Survey, are constantly called upon for a wide variety of information. Letters received at the Geological Survey from people in all walks of life run up into the thousands annually. Many mineral specimens are identified for the public. Work of this kind, including personal interviews, has to be considered a regular function of the geologist in public service. Sometimes the relation of geology to the question raised may at first seem remote, but the answer may reveal an intimate connection. For example, a representative of the United States Fish Commission called at my office one day. He was trying to restock with fish some of the streams in West Virginia. Though he was generally successful, there was one area where the young fish, when released, kept dying and he was not able to obtain satisfactory results. By referring to the county geologic map, a product of the state survey, it was found that the streams that caused the trouble all rose in or crossed a belt of pyrite-bearing shales, and it seemed probable that the unfavorable effects on the young fish were produced by sulfuric acid released by the decomposition and leaching of the pyrite in these shales, and its continual supply to the stream through springs in minute quantities but sufficient to kill the fish.

Another West Virginia problem was brought to my office by an engineer from a telephone company that was having trouble in maintaining its lines. The company, it appeared, had laid these out with regard only to directions of route and mileage. It had not considered the nature of the ground in which its poles must be set. As a consequence disturbance of poles, disarrangement of line and breakage of wires was frequent because of land slips. Recourse to the state geologic map, another product of the state survey, with some further explanations, demonstrated to the engineer the usefulness of such a map in showing the position of the stable rocks that could be safely utilized and of the unstable formations that should be avoided.

GEOLOGY IN DOMESTIC RELATIONS

In the glaciated parts of the country, especially in New England, the land of many farms is stony. In the process of cultivation large numbers of stones, ranging in size from a few inches to as much as a foot in diameter, have been patiently gathered by the farmer and assembled in piles here and there in the fields or built into stone walls. Such walls are a characteristic sight along many New England roads. Successive winter frosts gradually lift other stones in the upper soil within reach of the plough and thus provide the farmer with additional crops of boulders.

Contrasting geologic conditions affecting the lives of whole communities have been called to public attention in the last year or two by the so-called "dust bowl" in the western states and by flooded areas of the Ohio, Mississippi and other rivers. In the dust bowl area cultivation, deficient rainfall and high winds combined

to loosen soil and transport it in large quantities to other sites near or far. The farms from which the soil was taken were depleted or ruined, whereas those that received it were improved, if not choked by too much sand or other deleterious material. On the other hand, the flooded areas suffered from the effects of too much rain and from the consequent increase in the transporting power of the rivers. One man's loss was perhaps another's gain in the redistribution of soil that took place during the flood.

An understanding of the effects of heavy rains and run-off on ploughed ground is essential to a farmer if he is to conserve his fields and maintain the productivity of his farm. This is especially true if his fields slope more than a few degrees. The system of contour ploughing now being introduced in many parts of the country, especially in the South, is doing much to prevent soil erosion and the waste of arable land.

My efforts to make a garden in Washington during the World War were directly affected by the geology of my back yard. The upper few inches of soil were derived from gravels of the Columbia group of Pleistocene age and were very stony, the stones ranging from birds egg to football size. They lay on an old deeply weathered and rotted schist of Precambrian age, the contact being beautifully exposed in a cut bank in the alley behind my house. Every square foot of that garden had to be opened by pick and shovel methods. Many wheelbarrow loads of pebbles were taken out and fresh dirt that had been dumped on the hillside behind wheeled in. The rotted schist seemed to have the consistency of lead. Only by persistent effort was the soil lightened and made ready for cultivation.

The practice of insulating houses and office buildings has given rise to a relatively new industry. Some of the more widely used insulating materials are of mineral origin, and locating suitable supplies of them requires geological investigation.

The question of keeping a cellar dry during a wet season, especially where frost and melting snow are involved, is dependent on recognition of the geologic conditions in the immediately underlying or surrounding ground. A ledge protruding into the cellar, or a water-bearing layer in the surrounding ground, if not properly sealed off, may lead water into the house and flood the cellar.

The location of cities, villages, individual dwellings and farms without regard to existing geological conditions, or perhaps in spite of them, has led to many disasters on both a small and large scale. This involves the whole question of disasters due to earthquakes, floods, hurricanes, volcanoes and other geologic agencies. Sometimes the advantages offered by such locations are great and the manifestations of adverse geologic conditions infrequent. Nevertheless, sooner or later they appear and those caught unprepared suffer. Special forms of insurance against disaster are available in some parts of the country. If the cost of protective measures is great, most people prefer to take their chances, but if in such places care is taken to select favorable ground and attention is given to protective types of building construction, the dangers of such disasters in individual cases, at least, may be largely obviated. However, any one who elects to live in such places should realize that potentially disaster-producing agencies are part of his natural environment and if he fails to take these into account he does so at his peril.

Geology in Education

The field of education is broad, embracing all those facts, influences and processes by which the student is made aware of the experience of the past and is prepared to go forward on his own initiative in the business of life and in extending the bounds of knowledge. Naturally many subjects enter into any well-rounded educational program. Some of them, notably geology, quicken observation, broaden understanding, stimulate the love of beauty and cultivate the mind.

One of the greatest contributions of geology to education is the concept of the length of geologic time. This and the astronomical concept of distance in space are among the greatest contributions of science to human knowledge. They serve to put in perspective all happenings on the earth and throughout the universe. The later methods of estimating geologic time, though permitting more exact statement of the lengths of individual periods or eras, emphasize the great age of the earth in contrast with the brevity of recorded history. Thus the age of the earth and the geologic record of the development of life upon it furnish a background for religion, philosophy and social science.

Geography, a subject included in practically every educational program, rests on geology. The progress of life through the ages as shown by the geologic record has depended largely upon geological conditions. Faunas have waxed and waned with the advance and retreat of seas over continents. Floras and vertebrates have responded similarly to the movements of the great ice-sheets. The present distribution of plants and animals shows many peculiarities due to these agencies and to isolation of certain inhabited areas from other corresponding areas by submergence or other geologic causes. The fauna and flora of Australia are well-known examples. The natural conditions that have favored the location of manufacturing or maritime cities, trade routes and transportation lines are generally traceable to geologic causes.

History plays a great part in education. Many

historical events from earliest times have had a geological background. Tribes and nations have developed their own customs and habits according to whether they lived in mountain glens or broad alluviated country; in continents or islands. Great civilizations have arisen at the mouths or on the plains of great rivers. These favorable natural features are the products of geologic agencies operating on rocks of different kinds through long ages.

According to trustworthy authorities, the great deluge of Biblical days, as well as the devastating flood of this century at Galveston, Texas, was the result of a chance combination of hurricane and tide in low coastal and estuarine areas. Mountain passes, products of geological agencies, have helped or hindered movements of peoples or armies. The Germans took advantage of the lowlands in Belgium in beginning their first advance in the world war. Accounts of battles have shown that the geological nature of the terrain is always an important factor in any victory or defeat. However, the great underlying causes of wars are economic and depend in large measure upon the distribution of supplies of usable mineral raw materials whose origin and distribution are geological problems.

The observation and study of nature is a prime element in any modern educational program. Nature is so full of geology that one can hardly look in any direction without seeing something of geological interest. Classes in nature study may have different objectives, but geologic materials and processes are always available and may either furnish the major interest or play some subordinate part. Geology lends itself readily to the inculcation of methods of scientific study. Either induction or deduction may be employed. The method of multiple working hypotheses outlined by Gilbert[2] many years ago is a noteworthy contribution to scientific education.

Geologic literature, like that of other sciences, or literature in general, contains much that is commonplace. Nevertheless, in the hands of its masters it has risen to heights worthy of the emulation of any student of English as well as of the sciences. Some years ago I came upon such a passage written by Sir Archibald Geikie.[3] It has lingered in my memory ever since. Discussing stratified rocks of Precambrian age, he writes:

> Few parts of the stratified crust of the earth present greater interest than these earliest remaining sediments. As the geologist lingers among them, fascinated by their antiquity and by the stubbornness with which they have shrouded their secrets from his anxious scrutiny, he can sometimes scarcely believe that they belong to so remote a part of the earth's history as they can be assuredly proved to do.

The shores of the British Isles have suffered severely from marine erosion, fine examples of which may be seen at many places along their coasts. The islands are small enough to enable almost any one who so desires to view the activities of the ocean and the effects that winds, waves, currents and tides have produced. It is therefore not strange that poetic and artistic genius should be stirred by scenes like these. Such may have been the background of Tennyson's poem, "Crossing the Bar," which has brought peace and comfort to vast numbers of people.

Mendelssohn's celebrated overture to Fingal's Cave, still heard in symphony concerts, was composed after his visit to the Island of Staffa off the Scottish coast in 1829. Thus literature and art have been enriched by interested observation of geologic processes and products.

Sometimes art, as well as business, may be promoted by proximity of needed materials. Professor Shaler used to say that the reason Greek sculpture advanced to such heights of excellence was the fact that in the marbles of Attica the Greeks possessed an unrivaled medium for the expression of their art.

In the ordinary prosecution of his work the geologist brings to light facts, principles and ideas of great educational value. His reports, papers and discussions serve as the basis for text-book compilations, classroom studies and field excursions. As a branch of scientific knowledge the cultural value of geology can hardly be overestimated. The literary value of its better products is high, its logic and broad philosophies stimulate the mind, and its factual content has worldwide interest.

SUMMARY

Geology through its bearing on supplies of mineral raw materials, necessary adjuncts to our civilization, enters into many relations of local and national importance. The information it supplies is basic to many great industries. It also enters into more intimate human affairs. Truly it may be said that the relation of human life to geology is as close as that of a fish to water. The earth on which we walk, the air we breathe, the water we drink, the daily events of our lives and even our higher endeavors and aspirations, are ordered or affected by geologic phenomena and principles. Though mystery, in the sense of things we can not explain, enters into geology as it does into life itself, its commoner aspects are so clear, so instructive and so enticing if once sensed, that they can hardly fail to appeal to the imagination and interest of any active mind. Let us each continue striving to extend the knowledge and appreciation of our science.

[2] G. K. Gilbert, *Am. Jour. of Science,* (3), 31: pp. 284–299, 1886.

[3] A. Geikie, "Text Book of Geology," 4th ed., Vol. II, p. 876, New York, 1903.

OBITUARY

UPENDRA KUMAR DAS

DR. DAS, research associate in charge of the biochemical laboratory at the Experiment Station of the Hawaiian Sugar Planters' Association, was instantly killed by an explosion of apparatus in his laboratory on October 22, 1937. His passing away, just as he was equipped for still finer research, has deprived us of a thorough scientist who was motivated by, and never lost sight of, the practical viewpoint.

Born in India on July 23, 1902, he received his early education at Tagore's School. Coming to Honolulu in 1924, he enrolled at the University of Hawaii. Majoring in sugar technology, he completed the work for his bachelor's degree in three years and in June, 1927, was graduated with honors. While attending the university as an undergraduate, his earlier acquired analytical point of view, coupled with his optimism, his happy nature and his personal kindness, won the respect of his classroom associates, and on the athletic field, his skill was recognized when his team-mates elected him captain of the university soccer team. After his graduation, although then employed, he found time to secure additional experience in the laboratory of biological chemistry at the University of Hawaii and in 1930 was awarded his master's degree. Securing a leave of absence from his work in 1934, he spent a year in residence at the University of Minnesota and realized one of his earlier ambitions when he received his doctor's degree in 1935. While at Minnesota, he was elected to Sigma Xi.

The life of young Dr. Das was intimately connected with the Experiment Station of the Hawaiian Sugar Planters' Association. While still a student at the university, he became associated with the station as a part-time student assistant. Upon graduation, in 1927, he was appointed an assistant agriculturist. Thus, he had ample opportunity to get first-hand contact with field problems and learned to know the sugar-cane plant as it grew in the field under many and varied conditions. This experience contributed very largely to all his work thereafter and gained for him the respectful attention of the practical field men in whose problems he became interested.

His contributions to sugar-cane agriculture were substantial and conspicuous. His discovery and perfection of the method of preserving cut cane stalks with their tassels has been largely responsible for the success of the present-day crossing technique which is used in Hawaii. This work was done while he was still a student assistant. His visit to India and return therefrom in 1930 with seeds resulting from numerous crosses of the hardy Indian canes, which he made in cooperation with the well-known Indian cane breeder, T. S. Venkatraman, added fine breeding material to the canes already in Hawaii. He devoted a number of years to weather studies and laid the foundation for a simple measurement of the effective temperature and added much to our understanding of temperature-yield relationships. During these early years, he never lost sight of the importance of cane quality and his next notable contributions dealt with cane juice quality. Thus, the results of his studies on the nature and progress of sugar storage in the cane plant were increasingly valuable and stimulating to his associates. The dominant influence of nitrogen fertilization upon cane quality was the subject of his more recent investigations, and many phases of this relationship are much better known because of his findings. After his return from Minnesota, he supplemented his earlier activity with a keen interest in the manufacture of levulose and in the possible values in some of the sugar mill by-products, and his results in this field have also attracted respectful attention.

Inasmuch as Dr. Das's work was so largely confined to sugar-cane problems, most of his generous contributions to the scientific literature appear in publications devoted to the sugar industry. Nevertheless, they were looked for and reviewed by many workers in scattered scientific organizations who had learned to recognize the intelligent insight into biological questions which they displayed.

By his death, the sugar industry is deprived of a practical scientist with high ideals of research, who still had much to offer. His associates have lost a sympathetic, constructive counselor, and his friends miss a personality that is not replaceable.

RALPH J. BORDEN

LEO D. WHITNEY

THE untimely death of a faithful and cheerful friend is always a personal tragedy. When such a man has had proper technical training, is industrious and successful in his sincere search for truth, his early passing is a distinct loss to science. Leo David Whitney, assistant agronomist with the Hawaii Agricultural Experiment Station at the University of Hawaii, was such a man.

Mr. Whitney, graduate of the University of California with a B.S. degree, was born in Santa Rosa, Calif., on May 11, 1908. During his two years' stay in the Hawaiian Islands he concentrated on the study of taro, *Colocasia* (*Caladium*) *esculenta,* the staff of life of the Polynesians. He visited the various islands of the Hawaiian group, gathering from natives and planters eighty-odd varieties and clons for growing in experimental plots in Honolulu. These he carefully described. He rediscovered and studied the seed of taro, and successfully raised many seedlings, some

with decided commercial possibilities. Besides his work on taro, he had become the acknowledged authority on the native and introduced grasses of the Islands. He published several novelties in this field and had far advanced in his manuscript on local range grasses. His monograph on the seeds of the genus *Pinus* is ready for publication. His various interrupted researches will be completed by his colleagues and shortly appear in print.

He died on November 7, 1937, after a week's illness in Honolulu, his short span of life crowded with achievement. Surviving are his bride, Mrs. Jacqueline Mitchell Whitney; his mother, Mrs. M. Emmons Whitney; two sisters and a brother, all of California.

O. D.

WAIALUA, T. H.

RECENT DEATHS AND MEMORIALS

DR. CHARLES MORTON SMITH, dermatologist and professor emeritus of syphilology at the Harvard Medical School, died on January 8 at the age of seventy years.

SIMEON E. BOOMER, for twenty-five years head of the department of physics and astronomy at the Southern Illinois State Normal University, died on January 3 at the age of sixty-three years. He was a member of the Illinois Education Association and of the Illinois Academy of Science.

DR. ALFRED BARTON RENDLE, for many years keeper of the department of botany in the British Museum, died on January 12 at the age of seventy-two years.

JAMES L. STARKEY, the well-known British archeologist, recently was shot and killed by Arabs while he was driving in his automobile near the village of Beit Jibrin. He was fifty years old.

Industrial and Engineering Chemistry states that to honor the memory of the late Julius A. Nieuwland, and to carry on the scientific research which he inaugurated, the University of Notre Dame has established the Julius A. Nieuwland Memorial Foundation. Its aim is "to continue projects already instituted by the man whose discoveries made possible the manufacture of synthetic rubber on a commercial basis, and to seek other outlets for pure research which, if successful, will redound to the benefit of American industry and workers." The foundation proposes the following immediate objectives: a chair of organic chemistry, \$125,000; a visiting professors' endowment, \$125,000; five research fellowships, at \$25,000 each, \$125,000; a lecture foundation endowment, \$50,000; a library and research materials fund, \$75,000; and a chemistry laboratory building, \$500,000. The initial gift of \$10,000 came from the Chemical Foundation, Inc., and a number of additional gifts have been received. Gifts are to be held in perpetuity under the administration control of a board of lay trustees.

A MEMORIAL program honoring the life and work of Madame Marie Sklodowska Curie, co-discoverer of radium, was held at Columbia University on January 20. Count George Potocki, ambassador from Poland to the United States, and Dr. Francis Carter Wood, director of the Crocker Research Laboratories, were among the speakers. Dr. John Dyneley Prince, Columbia professor emeritus of east European languages and formerly Minister to Jugoslavia and Denmark, presided.

SCIENTIFIC EVENTS

THE DANISH NON-MAGNETIC RESEARCH SHIP

The New York Herald Tribune gives the following account of the new vessel *Dana,* constructed for the Government of Denmark, which is to be added to the fleet of research ships employed by maritime nations for oceanographic study from which are mapped accurate charts of navigable waters.

It is stated that the British Admiralty has a non-magnetic research ship in construction which will serve as a replacement for the American non-magnetic ship *Carnegie,* of the Carnegie Institution, which was destroyed by an explosion several years ago.

The new Danish vessel, costing 1,000,000 krone (about \$440,000), is 147 feet long and is equipped with a large deckhouse containing three laboratories, lounge for the scientific staff, officers' mess and pantry. A teak house on the bridge deck contains chart room and master's quarters. Six cabins are provided for the investigators. The vessel has a double bottom with special fuel tanks to permit two months of uninterrupted sailing.

Driven by a 700-horsepower engine giving her a speed of twelve knots, the ship has been equipped with a special clutch arrangement which will transmit power from the engine shaft to the propeller shaft in such a way that the screw is electrically actuated at very low speeds. In this arrangement the ordinary connection between the engine and propeller is interrupted and the propeller shaft is driven through a reduction gear by an electric motor fed by a large generator coupled to the main engine. Equipment also includes an echo sounder, gyro-compass, wireless-direction finder and radio station, including telegraphy transmitters for short waves and a radio telephone transceiver.

Magnetic charts have been published. The new

British vessel, to be named *Research*, will, it is expected, complete data which would have been gathered if the *Carnegie* had completed her cruise. The *Research* will be of the same beam but slightly longer than the *Carnegie* and will be equipped with similar instruments. No date has as yet been set for her entrance in service.

The German research ship *Meteor* will resume oceanographic and meteorological work on the north Atlantic this month. On this year's voyage, which will last until July, the *Meteor* will cover an area between the Cape Verde and Canary Islands and the West Indies.

THE MT. PALOMAR OBSERVATORY

A description of the 200-inch telescope in course of construction for the Mt. Palomar Observatory of the California Institute of Technology has been contributed to Science Service by Dr. R. M. Langer, correspondent of the service.

It is expected that the dome of the observatory will be completed by February 5, and it is hoped that the completion and installation of equipment will be possible during the next two years. The external shell of the dome is still to be painted outside and in with aluminum paint, miles of wiring for electrical circuits are still to be put into place. The dome covers about half an acre and is 137 feet in diameter. Above a cylinder seventy feet tall is a slotted hemisphere through which the telescope looks out at any angle with the horizon.

The upper part, including the hemisphere and twenty-seven feet of the cylinder below it, can be rotated to any direction of the compass so that the instrument can see through the slot any part of the sky available in these latitudes. The slot is closed by shutters when the instrument is not in use.

The fixed part of the dome is devoted to offices, laboratories, storage spaces and photography rooms. On top of the thirty-foot outer wall is a circular track on which the movable upper portion of the dome rolls on thirty-two four-wheeled trucks, each carrying four heavy springs wound with inch and a half steel rods.

The room within this moving structure is solely for telescopic observation. There are no appendages or supports to impair the clearance of the telescope tube no matter which way it points. The vault is about ninety feet high from the floor of the observation room to the center of the ceiling. Visitors will not be admitted into this room but will have access during special hours to a gallery walled off and insulated from the main observing room.

The moving portion is built from ⅜-inch steel plate welded together from pieces from one to two hundred square feet each. No bolts or rivets are used and the plates are fitted to the required spherical or cylindrical shape in advance. One such plate weighs about a ton. The moving portion of the dome weighs about one thousand tons.

There are two great arches three feet wide and eight feet deep alongside the shutter opening, and a horizontal plate girder near the bottom of the moving part to keep the cylinder circular. The rigidity of the steel shell is such that only slight additional structural support is needed.

This inside framework was erected first to hold the plates during the welding process and to prevent buckling afterwards. This so-called monocoque type of construction, developed and used with such success in the airplane industry, gives the dome the right to be called streamlined in the sense that it is a modern edifice.

The inner surface of the dome is made up of aluminum-faced steel boxes four inches thick hung from the steel shell. These boxes contain layers of aluminum foil to keep out the heat of the sun so that when night comes the instrument will already be at night temperatures and no precious time will be lost having to wait for a gradual dissipation of heat and change of shape accompanying the cooling process.

Throughout, although in external appearance the classical aspect of a large telescope housing is of necessity retained, every appropriate improvement in modern engineering has been applied. Automatic adjustments will be used wherever possible.

THE CULTURE OF OYSTERS IN FLORIDA

The Fisheries Service *Bulletin* states that a new center for marine biological research has been acquired by the U. S. Bureau of Fisheries by the transfer to the bureau of the Quarantine Station of the U. S. Public Health Service on Santa Rosa Island, Pensacola, Fla. This laboratory will serve hereafter as headquarters for oyster investigations for Florida and for the eastern Gulf region.

The laboratory is on an island built artificially of ballast rock dumped by the sailing vessels which formerly visited Pensacola, and is separated from Santa Rosa Island proper by a narrow channel. The surface of the island has a layer of topsoil which supports an abundant growth of vegetation. A highway and bridge connect the island with the mainland. The buildings on the island include eight residences, a hospital and a machine shop. The largest residence and the hospital are being converted into laboratories for oyster investigations, while some of the other buildings will serve as quarters for the staff.

When it was learned several months ago that the United States Public Health Service had closed its station and that the property was available for transfer to another Government agency, Dr. Paul S. Galtsoff and Dr. A. E. Hopkins inspected the island and

reported that it would be a highly desirable location for the establishment of a central oyster laboratory for the area. The transfer was accordingly requested by the Bureau of Fisheries.

With the completion of special studies on the mortality of oysters in Apalachicola Bay, a temporary laboratory which was set up in 1935 on the shores of Indian Pass, about twenty-eight miles from the city of Apalachicola, has been moved to Pensacola. Indian Pass was found to be unsatisfactory for general studies of oyster culture because of the extreme variations in the salt content of the water and the large amount of silt.

Pensacola Bay provides especially favorable conditions for oyster cultural studies because the water is clear and there are no fresh-water streams in the vicinity so that the salinity may be expected to remain fairly constant. Under the direction of Dr. A. E. Hopkins the reactions of oysters to natural conditions in the Gulf area will be investigated, and various methods of culture will be tested on natural beds and in selected areas where conditions can be controlled. At some future time experimental beds may be established in other bays along the Florida coast for local testing of principles developed at the central laboratory. It is expected that the findings at the Pensacola station will be of practical application along the entire eastern Gulf area.

The new biological station may also be used as headquarters for investigations of other branches of the marine fisheries, including shrimp, shore fishes and the important reef fisheries.

GRANTS FOR RESEARCH ON INFANTILE PARALYSIS

A REPORT by Keith Morgan, national treasurer of the birthday ball celebrations of President Roosevelt that were initiated on behalf of the work of the Georgia Warm Springs Foundation, Inc., for infantile paralysis, is summarized in *The New York Times*. It is stated that the foundation has benefitted to the extent of $1,350,030 since the first birthday ball was held.

Mr. Morgan reported that in 1934 the birthday balls and other benefits yielded $1,003,030, which was given to the Georgia Warm Springs Foundation and was divided by the President into three funds.

A fund of $100,000 was established to stimulate and further meritorious work in the field of infantile paralysis elsewhere than at Warm Springs. Of the 1934 total, $650,000 was given to the Warm Springs Foundation to further its work. A fund of $253,030 was set aside for building, maintenance and contingencies of the foundation.

The Georgia Warm Springs Foundation received none of the receipts of 1935 which were divided on a basis of 70 per cent. remaining in the local communities where it was raised and 30 per cent., amounting to about $241,000, granted to fourteen universities and one research laboratory for poliomyelitis research investigation.

This fund was used to finance work on serums, nasal sprays, experiments with vitamin C and sex hormone feeding and other methods of protecting the public against infantile paralysis. It allocated on recommendations of a medical advisory committee, consisting of Dr. George W. McCoy, of the United States Public Health Service; Dr. Donald Armstrong, of the Metropolitan Life Insurance Company; Dr. Max M. Peet, professor of neurological surgery at the University of Michigan, and Dr. Thomas M. Rivers, of the Rockefeller Institute. The grants were as follows:

Stanford University (Professor E. W. Shultz), $30,000; University of Southern California (Dr. John F. Kessel), $25,000; University of California (Dr. Karl F. Meyer), $10,000; University of Chicago, Department of Surgery (Dr. Paul Harmon), $8,000; University of Chicago (Dr. Edwin H. Lennette), $3,000; Yale University (Dr. John R. Paul and Dr. James D. Trask), $10,000; Harvard University (Dr. W. Lloyd Aycock), $17,800; University of Michigan Medical School (Dr. Max M. Peet), $2,000; the Johns Hopkins University (Dr. Lewis H. Weed), $15,000; Long Island College of Medicine (Dr. Sidney D. Kramer), $20,000; New York University (Dr. William H. Park), $64,000; College of Physicians and Surgeons (Dr. Claus W. Jungeblut), $5,000; Health Research, Inc., Bureau of Laboratories, New York City (Dr. Ralph S. Muckenfuss), $10,000; University of Pennsylvania (Dr. Joseph Stokes, Jr.), $12,500; Western Reserve University (Dr. John A. Toomey), $2,100; University of Wisconsin Medical School (Dr. Paul F. Clark), $6,600.

The fund of $241,000 has now been expended. In New York City 70 per cent. of the total amount for 1936 was distributed among twelve hospitals, orthopedic institutions and other charitable organizations. In 1937 the sum of $51,319 was given to New York City, the national committee received $28,476, and $22,843 was retained for local distribution.

SCIENTIFIC NOTES AND NEWS

THE annual meeting of the British Association for the Advancement of Science will be held at the University of Cambridge from August 17 to 24, under the presidency of Lord Rayleigh. The following sectional presidents have been appointed: Mathematical and Physical Sciences, Dr. C. G. Darwin; Chemistry, Professor C. S. Gibson; Geology, Professor H. H. Swinnerton; Zoology, Dr. S. W. Kemp; Geography, Pro-

fessor T. Griffith Taylor; Economics, R. F. Harrod; Engineering, Professor R. V. Southwell; Anthropology, Professor V. Gordon Childe; Psychology, Dr. R. H. Thouless; Botany, Professor W. Stiles; Education, John Sargent; Agriculture, Professor R. G. Stapledon.

DR. FRANK BALDWIN JEWETT, president of the Bell Telephone Laboratories and vice-president of the American Telephone and Telegraph Company, will receive the Washington Award of the Western Society of Engineers for 1938. This award has been given annually since 1919 to "the engineer whose work has contributed most to human progress." Previous recipients include Herbert Hoover, Michael Pupin, Orville Wright and F. G. Cottrell.

PORTRAITS were unveiled at Columbia University on January 13 of Dr. Herbert E. Hawkes, since 1910 professor of mathematics and since 1918 dean of Columbia College, and of Dr. Cassius J. Keyser, who retired in 1927 with the title of Adrain professor of mathematics emeritus. The paintings were accepted by President Nicholas Murray Butler on behalf of the university. The portrait of Dean Hawkes, painted by Kendall Saunders and donated by a group of his friends, was formally presented by Dr. Frederick P. Keppel, president of the Carnegie Corporation. Dr. Harry J. Carman, professor of history, representing the donors, gave a small replica of the painting to Dean Hawkes. The presentation of the portrait of Professor Keyser, painted by Mrs. H. E. Ogden-Campbell, was made by Dr. George B. Pegram, dean of the Graduate Faculties. It was the gift of Mrs. Keyser.

A DINNER meeting in honor of Professor Russell H. Chittenden, emeritus professor of physiological chemistry at Yale University and director of the Sheffield Scientific School from 1898 to 1922, will be given during the fifth annual meeting of the American Institute of Nutrition to be held at the Southern Hotel, Baltimore, on March 30. Officers of the society for 1937–38 are: Mary Swartz Rose, *president;* E. V. McCollum, *vice-president;* G. R. Cowgill, *treasurer;* I. G. Macy, *secretary;* C. A. Elvehjem, P. E. Howe and L. A. Maynard, *councilors.*

A DINNER in honor of the eightieth birthday of Dr. Bernard Sachs, neurologist of New York City, which occurred on January 2, was given on January 8 by John S. Burke, president of the Altman and Friedsam Foundations. The guests included the trustees of the two foundations and representatives of the Academy of Medicine, Mount Sinai Hospital and civic organizations with which Dr. Sachs has been connected. Dr. Foster Kennedy was toastmaster, and speeches were made by Dr. William E. Grady, associate superintendent of schools; Dr. John H. Finley, editor of *The New York Times,* George Blumenthal and Mr. Burke, who presented to Dr. Sachs an engrossed testimonial autographed by the guests.

DR. FRANK M. ANDREWS, of the department of botany of Indiana University, has been named the fifth patron of the American Society of Plant Physiologists. The Charles Reed Barnes life membership in the society, awarded annually to "an outstanding plant physiologist," was given to Dr. H. L. Shantz, formerly president of the University of Arizona, now with the U. S. Department of Agriculture.

W. G. A. ORMSBY GORE has been elected president of the National Museum of Wales for the next five years, succeeding the Earl of Plymouth.

THE Genetics Society of America elected the following officers at the Indianapolis meeting: *President,* L. J. Stadler, U. S. Department of Agriculture and the University of Missouri; *Vice-president,* M. Demereč, Carnegie Institution of Washington, Cold Spring Harbor; *Secretary-Treasurer,* E. W. Lindstrom, Iowa State College.

OFFICERS of the Philosophical Society of Washington for 1938 have been elected as follows: *President,* N. H. Heck; *Vice-presidents,* F. G. Brickwedde and R. E. Gibson; *Corresponding Secretary,* W. G. Brombacher; *Recording Secretary,* H. E. McComb; *Treasurer,* H. F. Stimson.

AT the December meeting of the Sigma Xi Club of the University of Denver, Dr. Clarence M. Knudson, professor of chemistry, was elected president, and Dr. Margaret Fuller Boos, associate professor of geology, was elected secretary-treasurer.

DR. CARL R. FELLERS, research professor of food technology at the Massachusetts State College, has been elected president of the newly organized chapter of the Society of the Sigma Xi at the college. Other officers are: Dr. Walter S. Ritchie, head of the department of chemistry, *vice-president;* Dr. Henry VanRoekel, chief of the laboratory for poultry disease control, *secretary,* and Dr. Charles P. Alexander, acting head of the department of entomology, *treasurer.* The nominating committee consists of Fred J. Sievers, director of the Experiment Station; Dr. J. E. Fuller, research professor of bacteriology; Dr. W. H. Davis, assistant professor of botany; Dr. C. E. Gordon, head of the division of physical and biological sciences, and Dr. C. R. Fellers, *ex-officio.*

DR. ALDO CASTELLANI has been appointed visiting professor in the newly established department of preventive medicine and public health in the School of Medicine of the State University of Louisiana.

THE board of trustees of Princeton University has appointed incumbents of two newly established endowed professorships, in each instance of present

members of the faculty. Professor Clodius Harriss Willis has been made Arthur LaGrand Doty professor of electrical engineering, and Associate Professor Allen Goodrich Shenstone has been promoted to the 1909 professorship of physics.

DR. ROBERT A. MILLIKAN, of the California Institute of Technology, has been appointed chairman of the board of trustees of the Huntington Library and Art Gallery at Marino, Calif. He succeeds the late Henry M. Robinson, a banker of Los Angeles. An advisory committee has been formed to assist in administering the affairs of the library. Besides Dr. Millikan, the present trustees of the library and gallery are Herbert Hoover, Archer M. Huntington, George Ellery Hale and William B. Munro.

AT the annual meeting of the Board of Trustees of the American Museum of Natural History, Robert Woods Bliss, formerly United States Ambassador to Argentina, and Dr. William Procter, Bar Harbor, Me., president of the Biological Survey of the Mount Desert Region, were elected trustees. The present officers of the museum were reelected. These are: Dr. F. Trubee Davison, *president;* J. P. Morgan, *first vice-president;* Cleveland E. Dodge, *second vice-president;* E. Roland Harriman, *treasurer,* and Mr. Hay, *secretary.*

DR. GERALD WENDT, director of the American Institute of the City of New York, has been appointed by Grover A. Whalen, president of the New York World's Fair Corporation, to draw up a plan for coordinating the scientific displays. Mr. Whalen is reported to have said: "We do not intend to tell one chapter of the story of science in one single building. Rather we intend to disclose the whole story of modern scientific research, as far as is practicable, by adding a working scientific display in connection with every major exhibit."

DR. RALPH W. G. WYCKOFF, of the department of animal and plant pathology of the Rockefeller Institute of Medical Research at Princeton, N. J., has accepted a position with the Lederle Laboratories at Pearl River, New York.

DR. LEWIS A. CONNER, professor of clinical medicine at the Cornell University Medical College, New York, has retired as editor of the *American Heart Journal* after having served since the establishment of the journal in 1925. Dr. Fred M. Smith, professor of the theory and practice of medicine of the College of Medicine of the State University of Iowa, will succeed him. Associate editors are: Drs. Horace M. Korns, Iowa City; Hugh McCulloch, St. Louis, and Irving S. Wright, New York.

DR. THOMAS DOWNING KENDRICK has been appointed keeper of the Department of British and Medieval Antiquities at the British Museum, London, in succession to Reginald Allender Smith, who retired on January 4.

SCIENCE SERVICE reports that delegates to the Supreme Soviet of the Union of Soviet Socialist Republics include the biochemist, A. N. Bakh, a member of the Academy of Sciences of the U.S.S.R., elected from the Stalinogorsk electoral area of the Tula region; Professor Nikolai N. Burdenko, surgeon, already a member of the Moscow Soviet; T. D. Lysenko, plant scientist representing the Novo-Ukrainsky electoral area; Alexey Stakhanov, inventor of the production-rationalization system that bears his name, from a district in the Donetz Basin; Ivan Dmitrievich Papanin, chief of the four Russians camped on a Polar ice floe, elected from the Petrozavodsk electoral area in Karelia.

Nature reports that Dr. B. L. Bhatia, formerly assistant professor of zoology at the Government College, Lahore, later principal of the Government College, Hoshiarpur, and author of works on Ciliophora and Sporozoa in the Fauna of British India series, has established "The Science Press of India" as a science news agency for the daily press in that country.

DOUGLAS MARSLAND, of the department of biology of New York University, has leave of absence beginning on February 1. He plans to work at the Naples Zoological Station.

DR. JOHN FITCH KING, formerly of Munich, head of the department of chemistry of Williams College, has received a grant from the Oberlaender Trust and is now in Germany studying methods of training for the professional fields of science and the newer scientific work being done in Germany. Dr. King will carry on work chiefly at the Kaiser Wilhelm Institute for Chemistry at Berlin-Dahlem.

THE address of the retiring president of the Philosophical Society of Washington was delivered on January 15 by Dr. Frank Wenner, physicist of the National Bureau of Standards. His subject was "Time Measurements."

DR. E. V. COWDRY, professor of cytology at Washington University, St. Louis, lectured on January 12 at the Faculty Woman's Club of the Iowa State College on "Science Shapes the Future" and before the Graduate Faculty of the college on "Cellular Pathology." On February 7 he will speak at the Naval Medical School, Washington, D. C., on "The Problem of Leprosy."

DR. GEORGE H. ASHLEY, state geologist of Pennsylvania, gave an illustrated lecture before the Lancaster, Pa., Branch of the American Association for the Ad-

vancement of Science on the evening of January 20. The title of his lecture was "How Old is Man?"

PROFESSOR EMIL T. WITSCHI, of the department of zoology of the State University of Iowa, will be the guest of the Iowa State College Chapter of Sigma Xi on January 26. He will address the society on "Hormones in Development and Evolution."

THE two hundred and nineteenth regular meeting of the American Physical Society will be held at Columbia University on Friday and Saturday, February 25 and 26, as a joint meeting with the Optical Society of America. The preliminary arrangements of the program include a joint session with the Optical Society of America in a symposium on "The Optical Properties of Metals" at which the speakers will be Professor L. A. DuBridge, University of Rochester; Professor J. B. Nathanson, Carnegie Institute of Technology, and Professor H. A. Bethe, Cornell University. In addition there will be a lecture on "The Debt of the World to Optical Science" by Dr. Harlow Shapley, director of the Harvard College Observatory. This lecture will initiate the Adolph Lomb memorial lectureship established by the Optical Society of America. A meeting on April 28 to 30 will be at Washington, D. C., and the June meeting will be on the Pacific coast.

A $500,000 trust endowment for agricultural research has been established for the Michigan State College by the Horace H. Rackham and Mary A. Rackham fund. The first utilization of the fund will be the financing of study in the development of industrial uses for farm waste products. A board of trustees to administer the fund consists of Dr. Robert S. Shaw, president of the college; V. R. Garner, director of the Experimental Station; Hudson McCarrol, head of the chemical and metallurgical laboratories of the Ford Motor Company at Dearborn; Michael M. Gorman, editor of the *Flint Journal,* and Dexter Horton, of Ann Arbor.

DISCUSSION

POVERTY OF HUMAN REQUISITES IN RELATION TO INHIBITION OF PLANT DISEASES

THE writer spent the early spring to late fall of 1936 in Turkey (Asia Minor), exploring for certain plants under the auspices of the Division of Plant Exploration and Introduction, U. S. Department of Agriculture. In connection with seed collecting, surveys of vegetable plant diseases were made in different parts of the country. While making these notes it was interesting to find a marked absence of certain plant diseases in gardens of some villages. Occasionally it was possible to repeat visits to the same localities a number of times, and in places additional information was secured from Europeans and Americans living there. The conclusions reported in this paper are the result of only one season's observations, but it is believed they deserve to be published.

Diseases of cultivated vegetables occurred commonly in some localities, while in others they were apparently rare. In a few districts because of the nature of the terrain, gardening was possible only in restricted areas where irrigation and cultivation could be carried on, so that the gardened spots were very old. Wild plants growing outside of disease-free gardens were found with leaf spots and other fungus and bacterial infections, which indicated that some condition other than climate was probably effective in the phenomenal freedom from plant diseases in the gardens.

It appeared that, in general, the vegetables most nearly disease-free were growing in regions where there was a serious lack of certain natural resources. This was, of course, reflected as human poverty resulting in a vicious circle which in turn put its stamp on gardening operations. Places where healthy vegetables were so commonly produced were, for example, in sections where, judging from findings of archeological students, ancient civilizations had once flourished but had long since become much reduced. In such regions sufficient crops to support life for a limited number of human beings had been grown since prehistoric times. In many instances the mode of life of the growers was very simple and the material possessions minimized, a condition which the present Turkish government is evidently taking steps to alleviate. Apparently this economy of scarcity had become a stabilized condition that had existed for so long that it was taken as "the Will of Allah" by the peasantry, and they governed their living practices accordingly.

It appeared that people living under the difficulties obtaining in certain regions planned to produce their own seeds, to eat everything they grew and to feed their camels and asses every possible green leaf that was grown but not fit for human consumption. Fuel was at a premium in a number of the regions, and manure of animals was collected and dried for that purpose. In village gardens, workers were observed digging roots of harvested vegetables, which then were dried for fuel or fodder. The common method of fertilization of the gardens was the use of night soil mixed with ashes from the cooking and heating fires of dried animal dung.

Since rainfall was slight in many of the sections and water available for irrigation with primitive methods was meager and somewhat seasonal, the smallest amount was required to go the longest way. The

limitations were, in themselves, probably effective in arresting some development of parasitic plant diseases that require large amounts of rainfall. However, diseases needing the least amounts of moisture were also found to be quite uniformly absent in certain of the garden spots.

It is safe to estimate that in some situations human beings had grown crops under these difficulties for centuries. It is likely that in those days as soon as diseased plant materials were encountered in the gardens, they were removed and consumed by human beings or stock, or else dried and burned. Yellowed or spotted leaves were likewise removed and used as forage by early gardeners, as they are at present. Consequently, it seems the most severely diseased plant materials may well have been fed to animals, the manure collected and dried and used as fuel; thereby disposing of infective material. On questioning it was found the peasantry do not eat noticeably decayed vegetables. Indeed, at the present time, they eat comparatively few raw vegetables, and presumably they have not changed greatly in their dietary practices from long ago. It is reasonable to conclude that during many generations of cultivating these fields, little infective material has passed through the human digestive tract to be applied to gardens as night soil.

Manifestly what would appear to be an unintentional system of field sanitation has evolved in certain regions in Turkey. Restrictive causes have led to practices which might well be considered antagonistic to the perpetuation of many plant diseases. Of course it is appreciated that the inadvertent selection of disease-resistant strains of crops in some communities, together with the relatively dry climates encountered, may have been in themselves operative to a considerable extent in producing disease-free vegetables.

It was notable that in many places visited where human economy was unfavorable, vegetables were found growing markedly free from diseases of a bacterial nature, leaf spots of a parasitic fungus nature were lacking, stem or root-rotting diseases did not occur, and there was apparent absence of seedling trouble. While in other regions of the country where climatic conditions were similar but poverty of materials and resources was somewhat less apparent, plant diseases of all classes just noted were found in fair abundance, and in some cases they occurred with considerable severity.

It is to be regretted that numerical data could not be gathered that would give statistical evidence of the effect of unconscious field sanitation practices necessitated by meagerness of available natural resources. The securing of such figures would obviously require prolonged residence in the country so that observational evidence could be supplemented with experimental activities. Needless to state, human poverty is not suggested as a remedy for plant diseases nor as a beneficial state from any standpoint, even though gardeners of very poor economic status, living in regions of extremely scanty natural resources, may in some cases produce comparatively disease-free crops. Human poverty, unless it results in agricultural practices and economies of the character here described, can not be expected to bear any relation to plant diseases. The important point is that in certain areas visited in which there existed the most serious deficiency of human requisites, the dearth of those requisites had necessitated an agriculture that is essential to even a bare human existence and which appeared to inhibit the perpetuation of crop plant diseases.

A more detailed account of these plant disease surveys is being prepared, and will be presented at a later date.

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IRREVERSIBILITY OF CONDUCTION IN THE REFLEX ARC[1]

Conduction in the reflex arc is said to be irreversible; but, inasmuch as no nerve cell has yet been found to have but a single synapse upon it, nor has a nervous impulse ever been shown to be effective across a single synapse in either direction, there is neither logical nor empirical justification for inferring any irreciprocity of the individual synapse.

There is good evidence that a synapse is, as Keith Lucas suggested, a "region of decrement" which, in the cases so far reported, reduces the impulse to subthreshold value and thus, for transmission, requires summation. Lorente de Nó's recent measurements of the period of latent addition at the synapse have shown it to be of the same order of magnitude as the refractory phase. Hence, temporal summation at a single synapse is extremely improbable—whereas spatial summation from neighboring synapses is possible anatomically and known to occur physiologically.

Because subthreshold stimulation does not set up a propagated disturbance, spatial summation can only occur from synapses close together on the cell receiving the impulses; and, because the separation of synapses, measured along that axon whose endings they are, is great in comparison with the separation of synapses, measured along the surface of that cell body and its dendrites, to which they are applied, spatial summation will occur mainly in one direction only—and this will obtain though many synapses upon a single cell be terminations of a single axon.

[1] From the Laboratory of Neurophysiology of the Yale University School of Medicine, New Haven, Conn.

If, then, for any reason, summation is required for transneuronal conduction and temporal summation at the individual synapse does not occur while spatial summation occurs from many axonal terminations upon one cell but not in the reverse direction, transneuronal conduction can only occur in the direction in which it does occur in the reflex arc.

In brief, even though there be no irreciprocal property of the individual synapse, there may still be irreciprocity of transneuronal conduction.

Three characteristics of such conduction have in times past been commonly explained by attributing special properties to synapses. Lorente de Nó has demonstrated that the prolonged period of temporal summation in such conduction depends upon delay paths (Forbes) and reverberating chains of internuncial neurons and not on any protraction of the period of latent addition at the synapse itself. Gasser has already accounted for the inhibition in reciprocal innervation in terms of threshold changes in necessary internuncial neurons, instead of in terms of inhibitory synapses. Thus the explanation here offered for the irreversibility of conduction in the reflex arc, without the assumption of irreciprocity of the synapse itself, renders it now unnecessary to attribute to any individual synapse any property except that of a region of decrement.

W. S. MCCULLOCH

DARWIN AND EARLY DISCOVERIES IN CONNECTION WITH PLANT HORMONES

IN the November 19 issue of SCIENCE (p. 468) Professor N. Cholodny calls attention to the point that Charles Darwin first set forth the basic idea of the present hormone theory of tropisms, and that the subject is incorrectly treated in P. Boysen Jensen's "Die Wuchsstofftheorie" (G. Fisher, Jena, 1935), as well as in our English translation and revision of the book.[1]

Reference to the original text (p. 1) shows Darwin's name the first to be treated in the historical discussion of the subject, and Darwin (p. 405)[2] is quoted: "Wir müssen daher folgern, dass, wenn Sämlinge einem seitlichen Lichte frei ausgesetzt sind, ein gewisser Einfluss vom oberen Teil nach dem unteren hingeleitet wird, welcher die Ursache ist, dass sicht der letztere biegt." Similarly, on page 3 of the translation it is stated that Darwin (p. 474)[3] concluded "when seedlings are freely exposed to a lateral light, some influence is transmitted from the upper to the lower part, causing the latter to bend," and on page 4 in the pictorial treatment of the "historical outline of the early discoveries concerning plant growth hormones," Darwin's classic experiment is illustrated, together with those of other early workers. Cholodny cites Darwin as concluding that "these results seem to imply the presence of some matter in the upper part which is acted on by light, and which transmits its effects to the lower part." Boysen Jensen in 1910–11 supplied the *evidence* which enabled him to establish as a fact the opinion which Darwin expressed thirty years earlier; this evidence permitted the definite conclusion that the influence transmitted in tropic curvatures consists of a "substance or of ions."

If we erred or inadequately treated the work of Darwin or any other contributor to this field, it was entirely unintentional. We felt that Professor Boysen Jensen had, as a matter of fact, done a real service in calling attention to Darwin's work. No important mention of it has been found in English reviews published before the translation.

We had hoped that the pictorial treatment referred to above might be perfectly just to all workers, and at the same time illustrate the point so aptly brought out by Professor W. J. Robbins[4] in his reference to the history of growth substance discoveries: "This history, brief and fragmentary as it is, demonstrates that scientific knowledge accumulates slowly; that it does not spring full-formed from the mind of any one individual, but is the result of the contributions of many."

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[1] P. Boysen Jensen, "Growth Hormones in Plants." Translated and revised by Avery, Burkholder, Creighton and Scheer. McGraw-Hill. New York, 1936.

[2] C. and F. Darwin, "The Power of Movement in Plants." London, 1880.

[3] C. and F. Darwin, "The Power of Movement in Plants." D. Appleton-Century Co., New York. 1881.

[4] W. J. Robbins, *School Science and Mathematics*, 15[illegible]–167, February, 1937.

NITROGEN IN THE NUTRITION OF TERMITES

THE rôle of the symbiotic protozoa found in the hind-gut of certain species of wood-eating termites has been the subject of numerous investigations and is still a debatable question. Cleveland (1925)[1] cultivated reproductive colonies of termites for more than 1[illegible] months on a diet of filter paper and concluded that the termites could live indefinitely on a diet of pure cellulose, although he was at a loss to account for the source of nitrogen required for their forty-fold increase in weight. He concluded that "they must be able in some way to fix atmospheric nitrogen which

[1] L. R. Cleveland, "The Ability of Termites to Live Perhaps Indefinitely on a Diet of Pure Cellulose," *Biol. Bul.*, 48: 289–293, 1925.

they use in manufacturing proteins; or else, contrary to the current opinion, they must be able to transform carbohydrates into proteins." He was unable to demonstrate fixation of atmospheric nitrogen, and, as the other alternative is obviously impossible, the question of the source of nitrogen was left unanswered. Cook and Scott (1933)[2] have questioned the ability of termites to survive on a diet of cellulose, and presented data to show that termites require a diet including carbohydrates, proteins, salts and vitamins A, B, D and G. These authors used as criteria viability and group weight of non-reproductive colonies over a relatively short period of time, and also placed considerable weight on the presence or absence of cannibalism. These criteria are subject to some criticism because, as pointed out by Hendee (1935),[3] cannibalism often occurs in normal colonies on a natural diet of rotten wood. This might account for a decrease in weight and numbers during the first few months which could not be attributed to a deficient diet. Even though the termites may not be able to survive indefinitely on a diet of pure cellulose, as claimed by Cleveland, his data indicate that the colony lived and thrived for a surprisingly long time on a diet of pure cellulose.

Although the writers have never worked with termites they have been interested in the general subject of symbiosis between insects and microorganisms. While reviewing the work on termites and protozoa there occurred to them a possible explanation of the apparent ability of termites to thrive on a nitrogen-deficient diet. Because the writers probably will never have an opportunity of testing the hypothesis experimentally it is presented here for what value it may have.

The hypothesis is based on a possible nitrogen cycle within the termite colony. The symbiotic microorganisms, including protozoa, bacteria and spirochetes, are localized in an enlargement of the hind-gut *behind* the point where the Malpighian tubules enter the intestinal tract. The urates and other nitrogenous waste products excreted by the Malpighian tubules are probably utilized as food by the microorganisms and elaborated into protoplasm. Since anal feeding (the feeding on excreta of other individuals) is common among termites, the bacteria and protozoa or their dead bodies obviously are consumed by some individuals of the colony. Refaunation has been considered the principal function of anal feeding. It may also play a part in the nitrogen economy within the termite colony. The synthesis of protoplasm from urates by the protozoa and the utilization of the dead protozoa as food by the termites would permit the same nitrogen supply to be used over and over. In this way the metabolic processes of the termite colony could continue indefinitely as long as carbohydrates are available. The maximum size of the colony would of course be limited by the amount of nitrogen originally available in the bodies of the founders of the colony. Within this limit such a nitrogen cycle within the termite colony would permit the colony to live for a very long time on a diet apparently consisting of cellulose only.

It is also possible that some nitrogenous matter derived from dead protozoa within the digestive canal is absorbed directly through the anterior region of the hind-gut, especially since one of the functions of the ileum is absorption. If this occurs the nitrogen would be used over and over by a single individual, increasing still more the efficiency of the insect's nitrogen economy.

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QUOTATIONS

JUBILEE MEETING OF THE INDIAN SCIENCE CONGRESS

THIS week, the twenty-fifth meeting of the Indian Science Congress Association opens in Calcutta, the jubilee being marked by the attendance of a strong delegation from the British Association; Lord Rutherford was to have presided at the meeting, but fate decided otherwise, and the association has been fortunate enough to persuade Sir James Jeans to take his place. It may be hoped that this meeting will confirm the growing appreciation in India of the value of modern science.

In the address prepared for the meeting by Lord Rutherford before his death, he pointed out that prior to the first decade of this century scientific research in India was, with a few notable exceptions, confined to the great scientific services, initiated and maintained on a generous scale by the government, such as the Survey of India, the Geological Survey, the Botanical Survey, the Departments of Agriculture and Meteorology, and others. To the work of members of the Trigonometrical Survey we owe the principle of isostasy, while the development of the mineral resources of the country has been due largely to the activities of the Geological Survey. In forestry, the fine research institute at Dehra Dun is a monument

[2] S. F. Cook and K. G. Scott, "The Nutritional Requirements of *Zootermopsis* (*Termopsis*) *angusticollis*," *Jour. Cellular and Comp. Physiol.*, 4: 95–110, 1933.

[3] Esther C. Hendee, "The Rôle of Fungi in the Diet of the Common Damp-wood Termite, *Zootermopsis angusticollis*," *Hilgardia*, 9: 499–525, 1935.

to the enthusiasm of past members of the Indian Forest Service. The Indian Medical Service has been the means of giving the world, not India alone, new weapons for the attack on tropical diseases such as malaria, cholera and leprosy.

While this work was going on steadily, the Indian universities were being founded, and at first attention was mainly directed to the instruction and examination of students. There were always a few, however, who realized the rôle the universities must eventually take in the promotion of research, and, as a result of the Curzon Commission on Education in 1904, many of the universities introduced honors courses, and by new appointments and improvements in laboratories stimulated research in science. Amongst the pioneer men of science in India who distinguished themselves by original investigations, Lord Rutherford mentioned in his address Sir Alexander Pedler, Sir J. Chandra Bose, Sir Alfred Bourne and Sir Prafulla Rây.

For geographical reasons, personal contact between scientific workers in India is difficult. Occasional meetings of specialists may be arranged by the Board of Scientific Advice, but these meetings do not affect the university teachers, and in the autumn of 1911 two newly appointed professors, P. S. MacMahon in Lucknow and J. L. Simonsen in Madras, feeling the isolation in which they worked, considered that the time was ripe for the organization in India of a body having the same aims and functions as the British Association for the Advancement of Science. After considerable discussion, and acting on the advice of Sir Thomas Holland, a small committee was constituted to consider the formation of such a body. This committee met on November 2, 1912, and it was decided to ask the Asiatic Society of Bengal (now the Royal Asiatic Society of Bengal) to arrange for the holding of a science Congress in Calcutta in January, 1913. Various difficulties, however, necessitated the postponement of this meeting until January, 1914. The arrangements for the meeting were in the hands of the Royal Asiatic Society of Bengal, and thus commenced an association to which the Congress undoubtedly owes much of its success. The organization of the Congress has followed closely that of the British Association, although, in view of their special importance in India, sections of medicine and veterinary science were included.

The numbers attending the first meeting, when the late Sir Asutosh Mukherjee, vice-chancellor of the University of Calcutta, was president, were small; some thirty scientific communications were read, mainly by authors resident in Calcutta or its vicinity. This appeared to justify the critics of the scheme who had suggested that geographical difficulties would preclude its success. However, the Government of India early recognized the potential value of the Congress and authorized the payment of expenses to selected government servants. As a result, the second meeting, in Madras in 1915, was more largely attended and communications were received from authors as far distant as the Punjab and Ceylon. Since these early days, the Congress has grown very greatly, as shown by the size of the *Proceedings,* which in 1914 filled six pages and in 1928 four hundred and twenty.

Whilst this increase in the number of communications read to the various sections provides evidence of the growth of scientific inquiry in India, the main success of the Congress has been, as the original promoters had hoped, in the social contacts which it has provided and the public interest in science which it has aroused in the various centers it has visited. It has stimulated also the formation of such specialist societies as the Indian Botanical Society and the Indian Chemical Society.

While substantial progress in both teaching and research has been made by the universities of India, their responsibilities—and with them those of the Indian Science Congress Association—must inevitably increase. In this present scientific age, efforts are everywhere being made to develop natural resources to the utmost, to improve industrial processes and to increase our knowledge in pure science. It is to the universities and technical institutions that we must look for men to carry out this work. The universities must be able, not only to give instruction, but also to select those who are to be trained in the methods of research. From the latter we may expect to obtain future leaders of research, on whom the prosperity of the country will largely depend.

The utilization of science implies, moreover, a planned scheme of research. Here the experience of some of the Overseas Dominions may prove of service to India. In Canada and in Australia, there are State or Provincial Governments as well as a Federal Government, and in both cases it has been found expedient that the research organization of the country should be truly national and responsible to the federal government alone. Even in an empire the size of India, where the resources and needs of various provinces are widely different, it would seem that centralized organization of research is the only way of avoiding waste of money and effort. The detailed planning of research must be in the hands of those with the necessary specialized knowledge, and they must be able to act without suspicion of political or racial influence. Here the Indian Science Congress Association has shown, over a long period of political turbulence, what can be accomplished, for a marked feature of the congress has been the complete absence of racial and communal strife; it has remained quite unaffected by these trag

influences, doubtless due in part to the tact of the various general officers and to the very valuable services of the secretary of the Royal Asiatic Society of Bengal, Mr. J. van Manen.

Since the foundation of the Indian Science Congress Association, it had always been hoped that it might prove possible to arrange for an over-seas visit of the British Association to India. The necessity, for climatic reasons, of holding such a meeting during the cold weather (November to February), the middle of the academic year, offered serious difficulties. However, they have now been overcome, and, moreover, the precedent has been established of sending a delegation to a joint meeting with another organization. This is undoubtedly of great significance. Valuable as are personal contacts within a country, such contacts with workers in other countries and the opportunity of seeing the conditions under which they work are of even greater value, while the presence of a body of distinguished scientific visitors in India can not fail to be a source of inspiration to students and scientific investigators in that country.—*Nature*.

SCIENTIFIC BOOKS

MADAME CURIE

Madame Curie. A biography by EVE CURIE. Translated by VINCENT SHEEAN. Doubleday, Doran and Company, 1937.

THIS book is a reverent tribute to a gifted person and a sterling human being. Eve Curie, one of Madame Curie's two daughters, has put her soul into the work, and the well-known author of "Personal History" has done a fine job in translating it. Since the book is for the million and not for the select few, the emphasis is very properly on the personality of the heroine (and on *her* hero, Pierre Curie) This is as it should be; for the technical details involved in the discovery of radium have been described many times.

Much as one admires the scientist, the temptation here is to admire the woman as woman even more. In a world so distracted as the present, where the outlook of the caveman is applauded, the story of Marie Curie (and Pierre Curie, for the two are indissolubly bound) is the story of a noble spirit whose activity is, in a sense, a challenge to utter pessimism. Alas! We know only too well that great scientists do not always make fine men. What is called "truth" seems often a laboratory, but not a life necessity. But then, once in a while a Curie, a Rutherford, an Einstein appear if only to emphasize the absurdity of such a separation. All honor to the memory of a Marie Curie, who was a great scientist and a noble woman. All the more honor to her these days, when the tendency is for fanaticism to impose a goose-step rigidity of utterance; when tyrants seek to establish intellectual sterility.

The story starts with the child and the young woman in Poland. As Marie Sklodowska, the future Mme. Curie studies mathematics and physics in school and joins the rebellious Polish youth in their plan for an independent Poland. She lived to see a Poland reborn which set about persecuting its own minorities. But that was to come. In the meantime, we meet her again, this time in Paris. She lives in a garret six flights up. The room is cold, the food is scarce and the physics with Lippmann at the Sorbonne is absorbing. In 1894, when 27 years old, comes the touch of romance. She meets Pierre Curie. Somewhat later, Pierre discloses his love and his philosophy:

> It would be a lovely thing, in which I hardly dare to believe, to pass through life together hypnotized in our dreams: your dream for your country; our dream for humanity; our dream for science. Of all these dreams, I believe the last alone is legitimate. I mean to say by this that we are powerless to change the social order. Even if this were not true, we should not know what to do. And in working without understanding, we should never be sure that we were not doing more harm than good, by retarding some inevitable evolution. From the point of view of science, on the contrary, we can pretend to accomplish something. The territory here is more obvious and solid, and, however small it is, it is truly in our possession.

And so they marry, and work together and struggle together—on a salary of 300 francs a month, "comparable to that of a day laborer." Not until 1906, a few months before his death (he was run down by a truck and instantly killed), did Pierre get a chair of importance at the Sorbonne. In the meantime, they gave radium to the world. They took out no patents; they withheld nothing. "It would be contrary to the scientific spirit," said Marie; and Pierre agreed. They were carrying out their pact, to serve humanity; and humanity took what they gave, and thanked them very largely in polite speeches and empty honors.

Apparatus and equipment for the laboratory ate up the money obtained with the Nobel prize. The "laboratory" was an abandoned shed, with a leaky roof, and devoid of hoods to carry away poisonous gases. In bitterness does Marie write ("Pierre Curie," by Marie Curie): "Our society, in which there reigns an eager desire for riches and luxury, does not understand the value of science. It does not realize that

science is a most precious part of its patrimony." And again, in this book: "Humanity needs dreamers, for whom the disinterested development of an enterprise is so captivating that it becomes impossible for them to devote their care to their own material profit."

But she carried on. When Pierre died, she succeeded to his chair at the Sorbonne and continued the research work. Later on, with the establishment of the Curie Institute for Radium, she supervised the work of many—among them, the Joliots (her daughter, Irene, and her son-in-law), who were to receive the Nobel prize in their own right. She isolated radium in the pure state. For the second time she received the Nobel prize, the only instance of the kind on record. Years later, in Berlin, at the railway station, the crowd seemingly did not know whom to cheer more, Jack Dempsey or Madame Curie. But for all that, the august members of the French Academy of Sciences (with some notable exceptions) refused to elect her into their body because—she was a woman! In the spirit of science and logic with which he was so imbued, Academician Amagat closed his peroration with the declaration: "Women cannot be part of the Institute of France." The "immortals" finally gave way in 1922. They had become the butt of vaudeville performers.

Mme. Curie visited this country in 1922 to receive a gift of a gram of radium. She carried home this precious gift—a token from the women of America—together with as many honorary degrees as belong to President Butler.

She died in 1934. "Madame Curie," wrote Einstein, who knew her well, "is, of all celebrated beings, the only one whom fame has not corrupted."

To me the miracle of this volcanic period is that such women and men can be found to devote their lives to distant and often vague objectives in the midst of turmoil which distracts the minds of so many of us. These monks of 1938, devotees of the neutron, the hormone, etc., represent the immortal spirit which will not die.

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SPECIAL ARTICLES

SELENIUM AS A STIMULATING AND POSSIBLY ESSENTIAL ELEMENT FOR CERTAIN PLANTS

SELENIUM is the only mineral element known to be absorbed from the soil by food plants in sufficient quantities to render them lethal to animals.[1] Beath[2] and his associates have found that certain native plants —including several species of *Astragalus* (legume), *Stanleya* (crucifer), *Xylorhiza* (composite) and *Oonopsis* (composite)—always contain selenium when collected on seleniferous soils. The indicator plants frequently accumulate several thousand parts per million of selenium. Furthermore, the available evidence tends to show that some species of the indicator plants occur only on soils that contain selenium. The investigations reported by Byers,[3] as well as our own observations in South Dakota, Colorado, Wyoming, Idaho, Nevada and Utah, have shown a definite correlation between the distribution of Beath's indicator plants and the presence of selenium in the soil.

These facts obviously suggest that selenium may be an essential element for the growth of the indicator plants. Since the soils supporting these plants contain only small traces of selenium, it is evident that this element, if indispensable, belongs in the group of micrometabolic or microtrophic elements, which already includes manganese, boron, zinc, copper and perhaps others.

We have grown one of the indicator plants, *Astragalus racemosus*, in artificial media. This species occurs widely distributed, from North Dakota and Wyoming southward to Texas and New Mexico. Seeds that we had collected in South Dakota were germinated in quartz sand and then transferred to solution cultures and sand cultures. One set of plants was supplied with the usual mineral nutrients and the other sets had in addition various concentrations of selenium (as sodium selenite) ranging from 1 to 243 ppm. Though receiving a considerable quantity of selenium from the seed, the plants which were given no additional selenium made slow growth in comparison with those which obtained selenium from the culture solution. Marked stunting of the plants deprived of selenium became evident within a few weeks after their transference to the mineral solution.

These experiments show that selenium has a pronounced stimulating effect on the growth of *Astragalus racemosus*, and they suggest that selenium may be essential for the development of this and other species of selenium indicator plants. After we had completed one set of these experiments, we learned from Professor Beath that he has obtained somewhat similar results with soil tests. Germination and growth of

[1] For literature review, see S. F. Trelease and A. L. Martin, *Bot. Rev.*, 2: 373–396, 1936.

[2] O. A. Beath, H. F. Eppson and C. S. Gilbert, *Wyo. Agr. Exp. Sta. Bull.*, 206, 1935. *Jour. Am. Pharm. Assoc.*, 26: 394–405, 1937. O. A. Beath, *Wyo. Agr. Exp. Sta. Bull.*, 221, 1937.

[3] H. G. Byers, *U. S. Dept. Agr. Tech. Bull.*, 482, 1935. J. T. Miller and H. G. Byers, *Jour. Agr. Res.*, 55: 59–68, 1937.

A. pectinatus and *A. bisulcatus* were markedly stimulated when a soil low in naturally occurring selenium was treated with a solution carrying 40 ppm of selenium (as sodium selenite). It was found to be impossible to secure a stand of either of these species of *Astragalus* on a Cecil clay loam from North Carolina.

Since plants of *Astragalus racemosus* are stimulated by selenium and sometimes accumulate as much as 15,000 ppm without visible injury,[4] it is perhaps not surprising to find that they can tolerate a relatively high concentration of selenium in the culture solution. A solution containing 27 ppm of selenium (as sodium selenite) retarded root development but stimulated the tops. With 81 ppm the *Astragalus* plants were stunted and chlorotic, exhibiting symptoms similar to those of wheat and buckwheat plants in a solution containing one tenth this concentration.[5]

Selenium, if required by certain plants, is unique among the essential elements in being needed by only a few species of the higher plants, in the Leguminosae, the Compositae and the Cruciferae. Even in the genus *Astragalus* some species appear to be definite indicators, limited to seleniferous soils, while others are indifferent in their soil requirements. These facts suggest an interesting evolutionary development of tolerance and requirement of selenium by a small number of species belonging to distantly related families.

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A NEW AND RAPID DEHYDRATION PROCESS FOR VEGETABLES[1]

IN present dehydration processes the principal difficulties are: (1) the cost of fuel, (2) detrimental effects of high temperatures on the material being dried and (3) the length of time required. The process described below obviates these difficulties. It depends on the fact that certain toxic vapors, notably those of fat solvents and some toxic gases, have the property of rapidly increasing the permeability of living tissue and finally killing it. This results in a loss of turgor and a release or separation of juice from the solid material. The juice containing the water and soluble matter, such as sugars, can then be removed largely by inexpensive mechanical means at low temperatures. Subsequent drying of the solid residue is rapid because of its complete permeability and its low moisture content.

[4] Beath *et al., loc. cit.*

[5] A. L. Martin, *Am. Jour. Bot.*, 23: 471–483, 1936.

[1] Contribution No. 137 from the Carbohydrate Research Division, Bureau of Chemistry and Soils, U. S. Department of Agriculture.

In connection with studies on sweet potatoes used for starch manufacture it was found, for instance, that vapors of carbon tetrachloride, toluene, chloroform and other fat solvents and sulfur dioxide and chlorine gases increased the permeability of the roots so rapidly that they were reduced to a soft, water-soaked condition in a few hours. Wetting the surface of the roots with the liquid solvent accelerated the action, which began almost immediately and reduced the time of treatment to approximately one hour. Extrusion of drops of juice on the surface of the tissue occurred during the treatment. The juice from material in this condition was readily pressed out without crushing the tissue, since the latter had become tough and pliable. The pressed residue, which then contained only about 40 per cent. of water, dried very quickly at relatively low temperatures. This is in marked contrast with thin slices of untreated material which, even after a long period of drying under the same conditions, showed fresh tissue within.

The method was tried also on other vegetables, notably, red beets, string beans, carrots and rutabagas and was found to be equally effective. Losses in weight after pressing and after drying for thirty-six hours under atmospheric conditions to an "air-dry" state are given in Table 1.

TABLE 1
DEHYDRATION OF VEGETABLES

Material	Per cent. loss in weight on pressing	Per cent. loss in weight on drying	Solids content of juice degrees Baumé
Rutabaga	50.0	65.2	4.4
Carrot	60.2	74.4	4.3
Beet	85.0	93.3	5.4
Green beans	82.0	95.5	4.0
Sweet potato	50.0	64.0	7.4

A number of interesting points were noted in connection with these experiments. Most important, however, is the possibility of applying the method for quickly dehydrating and preserving perishable material. The juice concentrated to a sirup and the residue reduced to the "air-dry" condition will keep indefinitely for future use or manufacture.

This has been done on a fairly large scale with sweet potatoes. The dehydration is carried out in this case by grinding the roots to a pulp and treating the latter with sulfur dioxide gas. The treated pulp is then spun in a centrifuge to remove the juice and the solid residue further dried to about 12 per cent. of moisture. This final drying removes the last traces of gas. Fermentation tests have shown that sugars in the juice may be converted into alcohol.

The advantages of the process, for which a public service patent is pending, are that it provides a method

of storing fleshy plant material without loss from rotting, freezing, respiration, moulding, enzyme action, etc., and that it can be carried out at low pressures and temperatures, mainly by cheaper mechanical operations, as distinguished from ordinary methods of drying. This will result in a large saving of fuel costs and will also give a better dehydrated product because of the low temperature and rapid drying. In the manufacture of starch from sweet potatoes, these last considerations are important in preventing physical and chemical changes in the starch before it is extracted.

It is obvious that, due to the removal of soluble substances in the juice by this process, wide claims for the dehydration of vegetables for food use should not be made. There may of course be special instances where the loss of nutrients or flavor with the juice would not be undesirable. Concentrating the juice and recombining it with the dried material does not seem to be feasible because of the high fuel cost. It appears, at present, that the principal applications will be in those cases where the loss of juice is not vital, such as in the manufacture of starch from either sweet or Irish potatoes and other similar processes.

The simplicity and low cost of this method suggest that it may be carried out in small-scale plants located at the source of the raw product. The dehydrated material can then be shipped economically some distance for further manufacture. This seems an effectual means of conserving surplus crops, cull vegetables and other farm wastes. In this way the method should become of considerable economic importance.

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THE GROWTH AND CHEMICAL ACTION OF ACETOBACTER SUBOXYDANS UPON I-INOSITOL[1]

PREVIOUS communications from this laboratory[2, 3] have dealt with the preparation of sorbose and of dihydroxyacetone by the action of *Acetobacter suboxydans* upon sorbitol and glycerol, respectively. It seemed of special interest to test the action of the organism upon cyclic polyhydric alcohols, and i-inositol was the first compound of this type chosen for study. This compound is of biological interest not only because of its wide occurrence, but because Miller and co-workers[4, 5, 6] have shown the compound to be identical with Bios I. It was thought that if this compound could be biologically oxidized to ketone compounds, which might exist in reversible oxidation-reduction systems, some light might be thrown upon its rôle as Bios I. Moreover, this type of reaction would permit the preparation of cyclic polyhydric ketones not now available. The organism has been shown, in our laboratories, to oxidize the i-inositol to a compound which present results indicate to be a di-keto-i-inositol. Details of preparation and identification of the compound will be published later.

Some observations on the culturing of the organism on i-inositol are of special interest and are noted at this time. In preliminary experiments, a medium containing 3 per cent. of i-inositol and 0.5 per cent. yeast extract (Difco) was inoculated with a culture of *Acetobacter suboxydans* which had been grown on a sorbitol medium. Growth was good and the Schaffer-Hartmann[7] titration showed the formation of reducing material. However, it was found that the organism could not be carried on the inositol-yeast extract medium beyond the third transfer. The addition of as little as 0.1 per cent. of sorbitol to the above medium permitted indefinite subculture and high conversion of the inositol into the oxidation product.

The factor involved in the above phenomena is not surbose but is some other fermentation product of the sorbitol. The material is present in the filtrate obtained by separation of the bacteria from the medium by filtration through a Berkefeld filter; it is stable when heated for 10 minutes at 100°, but shows some slight deterioration when stored for three weeks at 30°. The bacteria, washed free from the fermented sorbitol medium, were unable to oxidize the inositol unless the filtrate was added. Detailed studies are in progress to determine the nature of this factor and whether it will affect the oxidation of other materials by the organism.

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[1] Contribution from the Department of Chemistry, Iowa State College. This work was supported in part by a grant from the Industrial Science Research funds for the fermentative utilization of agricultural products. The i-inositol was kindly furnished by Dr. Edward Bartow, of the University of Iowa.

[2] E. I. Fulmer, J. W. Dunning, J. F. Guyman and L. A. Underkofler, *Jour. Am. Chem. Soc.*, 58: 1012, 1936.

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THE EXCRETION OF PREGNANDIOL IN THE TOXEMIAS OF PREGNANCY

DETERMINATIONS have been carried out on the urine of pregnant women for sodium pregnandiol glucuronidate, an excretion product of progesterone, according

to the method described by Venning.[1] In cases of toxemia of pregnancy values below those for normal pregnancy have been obtained. In all cases of severe toxemias, clinically pre-eclamptic, none of the compound could be recovered.

In all the normal pregnant cases studied at various months of pregnancy, the values obtained for sodium pregnandiol glucuronidate were in keeping with those reported by Browne, Henry and Venning,[2] with three exceptions. In one of these three cases, no sodium pregnandiol glucuronidate was recovered in the fifth month, in another none of the compound was recovered in the ninth month, and in the third, a lower amount than normal was recovered. The urine of these three patients, however, when extracted for the unconjugated form of pregnandiol by a new method, was shown to contain the free form of the compound, pregnandiol. This free form of pregnandiol was recovered in amounts somewhat lower than the expected normal values calculated on the basis of the amounts excreted of the combined form of pregnandiol in other normal cases at corresponding periods of pregnancy.

In the course of these studies it was found that sodium pregnandiol glucuronidate in the urine is unstable and begins to hydrolyze at room temperature within a week and is almost completely hydrolyzed at the end of two weeks. The compound is rapidly hydrolyzed if the urine is allowed to stand at 37 degrees Centigrade for twenty-four hours. This form of hydrolysis in incubated urine results in very little loss of pregnandiol. Free pregnandiol has also been recovered from the fresh urine in those cases mentioned above, and in some cases of toxemia, by the same method, as is used to recover the free form after hydrolysis.

The details of this method as well as the values obtained for both the conjugated and the non-conjugated forms of pregnandiol, in the study of a series of cases of normal pregnancy and of the toxemias of pregnancy will be reported shortly.

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SCIENTIFIC APPARATUS AND LABORATORY METHODS

A METHOD FOR STUDYING AND INFLUENCING CORTICO-HYPOTHALAMIC RELATIONS

THE immediate effects of direct hypothalamic stimulation have been shown by many investigators to be rise in systemic blood-pressure, change in respiratory rate, dilatation of the pupils, elevation of hairs and movement of the nictitating membrane and, in addition, slower appearing metabolic effects. I have devised a method by which hypothalamic stimulation can be effected through the intact skull without entering and damaging the nervous tissue and hence it is also applicable to the human.

The hypothalamus of the cat lies about the posterior part of the hard palate at a site easily located by stripping the mucous tissues and periosteum and finding a midline bleeding point, the source of which is a vein lying in a bony canal, a remnant of the embryological craniopharyngeal duct. With experience this point can be located without reflection of the soft tissues. A probe is simply passed down to the bone in the midline at this point, making a circular opening of several millimeters in diameter in the mucosa. The outer table is tapped for a few turns and a small bakelite core screwed in. This bakelite core contains a silver electrode covered with cotton moistened with silver chloride solution. The electrode simply makes contact with the surface of the bone. Its end penetrates the top of the bakelite and an insulated lead-off wire is looped over it. An ordinary indifferent electrode is applied to the shaved neck. Relatively weak interrupted currents from an inductorium evoke typical hypothalamic responses, mentioned above, while stronger currents produce muscle movements in addition. Pain-producing stimuli in the neighborhood and elsewhere do not evoke these responses. It is suggested that the electrode may be left in place and stimuli applied to the conscious animal, repeated when desired, in order to study the slower acting effects of hypothalamic excitation within the metabolic field.

The electrode in the bone close to the hypothalamus has been used to lead off currents to amplifiers of an electroencephalograph made by Mr. Franklin Offner under the direction of Professor Ralph Gerard. The resulting waves have been compared to the cortical brain waves. In the electrohypothalamogram there are few alpha waves and definitely characteristic slow regular waves of low voltage. Preliminary studies show that stimulation of the hypothalamus produces changes in the cortical waves of an excitatory character, increasing the voltage of the alpha waves which become clearer and devoid of spikes and increasing the frequency of the alpha bursts. After stimulation fast beta waves increase in the cortical lead. Immediately after stimulation through the hypothalamic electrode the amplifier is switched back and the result of stimulation has been found to be an increase in frequency and voltage of the slow hypothalamic waves. Preliminary pharmacological studies indicate that intra-

[1] Eleanor Hill Venning, *J. Biol. Chem.*, 119: 473, 1937.
[2] J. S. L. Browne, J. S. Henry and E. H. Venning, *J. Clin. Investigation.*

venous adrenalin produces effects similar to hypothalamic stimulation, while pilocarpine causes effects in the opposite direction.

The human hypothalamus lies on the clivus of the sphenoid bone, either above or behind the sphenoid air sinus. There is much individual variation. A simple drilled steel cylinder slightly curved at the top, insulated with dripped celluloid, except for a few millimeters at the sharp pointed silver-plated tip, is used as a unipolar electrode. The turbinates are shrunk with adrenalin and, using an endoscope in one nostril, the electrode is passed through the other to the posterior pharynx. It is inserted far back in the vault of the pharynx, and at the junction of the roof and posterior wall it is pressed deeply through the mucous tissue until a crunching noise is heard. The electrode can be firmly embedded in the bone. Only slight pain occurs at its insertion. The patient is able to walk about and swallow normally with the electrode in place. No untoward results appear after its removal.

Stimulation of the hypothalamic electrode causes the usual signs of hypothalamic excitation, pupils dilating and blood pressure rising as high as 80 mm of mercury. In the human, too, a characteristic electrohypothalamogram can be elicited and the effects of hypothalamic stimulation on cortical brain waves studied. Pharmacological effects and other experimental situations may be studied by this method of comparing hypothalamic and cortical leads to an encephalograph as in the experimental animal. Larger currents sent through the hypothalamic electrode produce convulsive movements and marked changes in blood pressure, respiration and circulation. These cease gradually on cessation of stimulation. This method will be used to produce shock effects in schizophrenia as a substitute for insulin or metrazol, as it offers a safer, easier graded and quickly interrupted method of changing cerebral circulation. It seems more rational than the other methods because it directly influences the vegetative regulatory centers concerned with circulation and blood pressure, at the same time evoking the identical secondary effects by producing muscle twitchings. If the effect of "shock" in schizophrenia is psychological, the above method is equally adapted.

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THE CULTURE OF CHAOS CHAOS

PROFUSE cultures of *Chaos chaos*, Type A, Schaeffer strain, have been obtained by the following method:[1]

Prepare each finger bowl in the manner suggested by Brandwein—namely, by covering the bottom with a thin (1–2 mm) sheet of 1 per cent. aqueous solution of agar and implanting the agar, while it is still soft, with five preheated rice grains, distributed evenly on the surface. After the agar has hardened, add 80 cc of the general culture solution,[2] a few drops of a rich culture of *Blepharisma lateritia*[3] and several specimens of *Chaos chaos*. Maintain the culture at 17–19° C. Maximum growth is reached in about four weeks, and then sub-culturing is advisable.

Blepharisma lateritia, Actinophrys sol., Stentor coeruleus, Paramecium bursaria and *Paramecium caudatum* also propagate rapidly in the foregoing solution, used in conjunction with the agar and rice. In such cultures, Chilomonas also appears in abundance and, apparently, this small ciliate serves advantageously as food for the larger organisms.

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[1] A modification of the method of Paul F. Brandwein, *American Naturalist*, 69: 628, 1935.

[2] General Culture Solution: NaCl 1.20 gms, KCl .03 gm, $CaCl_2$ .04 gm, $NaHCO_3$ .02 gm, Phosphate Buffer Solution, pH 6.9–7.0, 50 cc; add distilled water to 1 liter. For use, dilute 1: 10, with distilled water (see footnote 1).

[3] *Chaos chaos* ingests Blepharisma in preference to Paramecium, Stentor and other ciliates which have been tried. In the cultures every specimen shows numerous food vacuoles containing the pinkish remnants of the digesting Blepharisma.

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